ASTM BULLETIN

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"Promotion of Knowledge of Materials of Engineering and Standardization of Specifications and Methods of Testing"

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Symposia on Thermal Insulating Materials and Lime, to Feature Regional Meeting

Spring Group Meetings at Columbus, Ohio, During Week of March 6 to 10

A STUDY of American history indicates that one Lucas Sullivant, a Virginian surveyor, made his way through Ohio in 1797 and settled on the west bank of the Scioto River near where the waters of the Olentangy River joined it. This was of course a scene of virgin wilderness, a part of the Northwest Territory. A little village sprang up which was called Franklinton after Benjamin Franklin. Ohio became the first state west of the Appalachians in 1803 and its General Assembly established the capital opposite Franklinton on the east bank of the Scioto River naming it Columbus after the discoverer of America. Some years later the two towns were merged.

This brief historic note concerning Columbus may be of interest to many of the large number of members who are planning to be in Columbus during the week beginning March 6, attending sessions of the various committees which will meet during A.S.T.M. Committee Week, and the Regional Meeting with Symposia on Thermal Insulating Materials and Lime, to be held on Wednesday and possibly Thursday, March 8 and 9.

The committee meetings and technical sessions will in general be held at the Deshler-Wallick Hotel which can provide the facilities required for an A.S.T.M. meeting. Further details concerning room rates and related matters will be forwarded early in February to all members of committees convening in Columbus.

LOCAL COMMITTEE ORGANIZED

Local arrangements for the meetings will be in the charge of a committee of members, in Columbus and neighboring Ohio centers. C. E. MacQuigg, Dean, College of Engineering, and Director, Engineering Experiment Station, Ohio State University is chairman of the group, and W. W. Heimberger, Buckeye Steel Castings Co., is secretary. Meetings of the committee have been held and plans are well under way for the development of the program, registration, entertainment, and other activities which will insure a successful meeting.

While further details of the committee's plans for the entertainment of members will be announced in the January BULLETIN and in direct communications to committee members who will attend, one interesting development can be announced at this time, namely, the plan of having an open house at Ohio State University, probably on Wednesday evening, March 8. Special activities are being planned which should be of interest to all members.

TECHNICAL FEATURES

As announced in previous BULLETINS, two technical features are being planned for the Regional Meeting, namely, a Symposium on Thermal Insulating Materials and one on Lime. Committees C-8 on Refractories and C-16 on Thermal Insulating Materials are cooperating jointly through a special committee in the preparation of the first-named session. Four extensive papers are being developed by authorities in this field, as follows:

THE EFFECT OF SOLAR RADIATION ON THE HEAT TRANSMISSION THROUGH WALLS—F. C. Houghten, Director, Research Laboratory, American Society of Heating and Ventilating Engineers.

FACTORS INFLUENCING THE THERMAL CONDUCTIVITY OF NON-METALLIC MATERIALS—J. B. Austin, Research Laboratory, U. S. Steel Corp.

A CONSUMER'S PROBLEMS IN SELECTING HEAT INSULATION—E. T. Cope and W. F. Kinney, The Detroit Edison Co.

METHODS OF TESTING THE PHYSICAL PROPERTIES OF PRE-FORMED AND PLASTIC THERMAL INSULATION—H. H. Rinehart, Johns-Manville Research Laboratories.

The paper by Mr. Austin will be fundamental in character and considers the theory of heat conductivity from several important standpoints. Further details of these papers will be furnished members and some consideration is being given to the possibility of publishing abstracts in the January BULLETIN or duplicating them in advance of the meeting.

The special symposium committee which has been charged with the work of developing the Symposium on Thermal Insulating Materials and arranging other matters in connection with it includes the following:

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Airview of downtown Columbus, showing state capitol in foreground; the A.I.U. Citadel, State Office Building and the Scioto River, spanned by the Broad Street Bridge.

Thermal Insulating Symposium Committee

J. H. Walker, Engineer Assistant to General Manager, The Detroit Edison Co., *Chairman.*

C. B. Bradley, Johns-Manville Corp., Research Labs.

E. T. Cope, The Detroit Edison Co.

R. E. Cryor, Research Engineer, Union Asbestos and Rubber Co.

H. C. Dickinson, Chief, Heat and Power Division, National Bureau of Standards.

R. H. Heilman, Senior Industrial Fellow, Mellon Institute of Industrial Research.

O. E. Harder, Assistant Director, Battelle Memorial Institute, representing the Columbus Committee.

M. F. Skinker, Director of Research, Brooklyn Edison Co., representing Committee E-6 on Papers and Publications.

The interest in thermal insulating materials, both for high temperatures and for room temperatures, has intensified during recent years and it is expected a large number of those concerned with the production and use of these materials will find the symposium of specific interest. While Committee C-16 has had several meetings and is making much progress in its work which will involve the formulation of specifications and methods of testing in the insulating refractories field, this is the first formal activity which the committee has undertaken.

The Symposium on Lime is being developed under the sponsorship of A.S.T.M. Committee C-7 on Lime. J. R. Withrow, Professor of Chemical Engineering, Ohio State University, chairman of Committee C-7 is directing the development of this symposium. Quite a number of technical papers are in course of development with others in prospect and a statement of the program is being prepared. It is expected that the papers will cover the properties and testing of lime, the relationship of manufacturing to the properties of lime and probably give pertinent information on various uses of this material.

COMMITTEE WEEK

As indicated previously, the 1939 Group Meetings of A.S.T.M. Committees will be held from Monday, March 6, through Friday, March 10. Quite a number of committees have already indicated their decision to hold sessions there and many others will undoubtedly take part. Further announcements concerning committees which are to meet will be made.

COLUMBUS

Since Sullivant established his home near Columbus, the city has grown until its population today is upwards of 310,000, with some 360,000 people if the metropolitan area is included. Columbus is the twenty-eighth city in population in the United States. Geographically it is about 565 miles by automobile from New York City, 145 from Cleveland, 325 from Chicago, 200 from Detroit, and about 180 from Pittsburgh. It is served by five of the country's leading railroads, numerous bus lines, and two air lines use its Port Columbus facilities.

There are wide ranges of industries represented in Columbus, with some 450 manufacturing establishments employing around 20,000 workers. Important industries include iron and steel products and machinery, food and leather products, paper and printing, vehicles and parts, etc.

Ohio State University at Columbus is the sixth largest in the United States, with an enrollment of around 16,000 students. Capital University, Franklin University, and Otterbein College are other collegiate institutions in the city or in its environs.

Of interest to members is the fact that Battelle Memorial Institute, one of the country's leading agencies for scientific research, members of whose staff are very active in Society work, and the Edward Orton Jr. Ceramic Foundation are located in Columbus. It is also the headquarters of the American Ceramic Society, whose secretary, Dr. Ross C. Purdy, is taking an active part in the local arrangements for the Regional Meeting and Committee Week.

Fundamental Research Discussed at Philadelphia Meeting

At a dinner meeting sponsored by the Philadelphia District Committee held at the Penn Athletic Club on October 17, Dr. L. W. Chubb, Director of Research, Westinghouse Electric and Manufacturing Co., spoke on the subject "Fundamental Research in Industry." Upwards of 150 members of the Society and their associates and guests were present at the dinner, coming from Philadelphia and other localities in the Philadelphia District.

N. L. Mochel, chairman of the Philadelphia District Committee, was toastmaster and introduced the President, T. G. Delbridge, and the Secretary-Treasurer, C. L. Warwick, who greeted those present and discussed briefly certain phases of the Society's work. A surprise feature of the evening was a short address covering certain of the difficulties encountered by scientists from abroad, the "learned doctor" in this case being impersonated by M. W. Dalyrymple, Bethlehem Steel Corp., who spoke from behind (or in the midst of) a really magnificent set of whiskers.

Doctor Chubb emphasized some of the important developments in the field of research, commenting on the value to physicists and scientists of mass spectrography and dwelt at length on the newer nuclear physics theories, thoroughly describing a large atom smashing apparatus being completed by the Westinghouse organization. Those present were impressed by the lucidness of his descriptions of this new theory and its many ramifications, and also the changing concept of our knowledge of the properties of materials which a thorough understanding of the nuclear theory may bring about.

Important Changes to be Made in Publishing Standards

Standards and Tentatives in Same Volume Starting in 1939

A COMMUNICATION to the members of the Society, dated November 8, announced important changes in A.S.T.M. publications and described in particular the consolidated book containing both A.S.T.M. standards and tentative standards to be published triennially, beginning with the edition appearing late in 1939. This announcement reviewed in detail the present method of publication, gave some facts about the growth of the Society work and listed advantages of the new publication set-up.

In brief, the new method of publication to begin in 1939 is to issue the standards and tentative standards collectively in one triennial publication, divided into three parts: I Metals, II Non-Metallic Materials—Constructional, and III Non-Metallic Materials—General. Publication of new and revised tentative standards in the *Proceedings,* Part I, will be discontinued; the *Proceedings* including both committee reports and papers (about 1300 pages double-column format) can be bound in one volume. The publication of the annual Book of Tentative Standards will be discontinued entirely. (The 1938 edition now nearing completion will thus be the last one issued.)

In the two years between triennial publication of the new Book, Supplements to each of the three parts will be issued, containing revisions and new or revised standards and tentative standards for that year. Since these books will be appreciably larger than the present supplements and will have permanent reference value, they will be bound in cloth. The volume on Methods of Chemical Analyses of Metals published in 1936 will be continued as a separate publication given to members without charge upon request. The annual publication of a collective Index to Standards and Tentative Standards will be continued.

This new plan provides that the three parts of the 1939 Book of A.S.T.M. Standards and Tentative Standards will be made up as follows:

PART I. METALS.—Ferrous and non-ferrous metals (all A and B and some E serial designations) except methods of chemical analyses. General testing methods (E serial designations).

PART II. NON-METALLIC MATERIALS — CONSTRUCTIONAL. — Cementitious materials, concrete and aggregates, masonry building units, ceramics, pipe and tile, thermal insulating materials (all C serial designations). Timber and timber preservatives, paints, varnishes and lacquers, road materials, waterproofing and roofing materials, soils (certain D serial designations). General testing methods, thermometers (E serial designations).

PART III. NON-METALLIC MATERIALS—GENERAL.—Fuels, petroleum products, electrical insulating materials, rubber, textiles, soaps and detergents, paper, plastics, water (remainder of D serial designations). General testing methods, thermometers (E serial designations).

As announced, the specifications and tests whether standard or tentative will be reset in the new double column format. Some of the advantages of this new format are discussed in another article in this BULLETIN (see page 39) in connection with which there are given facsimiles of the old and new styles.

The Executive Committee, after considering estimated increases in the number of standards, size and cost of future editions of the new publications, etc., has decided to furnish the new books to members on the following basis:

Members will receive on their dues any one Part of the Book (as they may elect) and its Supplements or

Members may procure any two Parts of the Book and their Supplements by paying annually $1.50 or

Members may procure all three Parts of the Book and their Supplements by paying annually $2.50.

Members will also continue to receive on their dues the annual *Proceedings,* preprints of committee reports, standards and technical papers, ASTM BULLETIN, Index to Standards and Tentative Standards, Year Book, and the privilege of reduced members prices on the increasing number of special publications issued by the Society.

The following sales prices are announced:

BOOK OF STANDARDS AND TENTATIVE STANDARDS PARTS I, II, III	*Any One Part*	*Any Two Parts*	*Any Three Parts*
List Prices (non-members)	$8.00	$15.00	$22.00
Members Prices (for extra copies)	5.50	10.00	14.50
SUPPLEMENTS FOR ONE YEAR			
List Prices (non-members)	3.00	5.00	7.00
Members Prices (for extra copies)	2.00	3.50	5.00
		Per Copy	
PROCEEDINGS, ANNUAL VOLUME			
List Price (non-members)		$9.00	
Members Price (for extra copies)		6.00	

As the folder to members pointed out, the next decade will almost certainly see the greatest expansion of our standardization and publication activities that has yet taken place, and under this new plan the way is cleared for development and growth along the soundest and most effective lines.

There was enclosed with the folder to each member a return card by which members could indicate which parts of the Book of Standards they wish to receive. It is urged that every member, if he has not already done so, fill out the card and mail it to Society Headquarters as soon as possible. The new plan involves a great deal of office record work and prompt return of the card will be very helpful.

Ohio State University campus covers 300 acres and has 900 adjoining acres of farmland. On the campus are ten colleges and a graduate school.

1939 Annual Meeting and Exhibit at Atlantic City

THE Society's Forty-second Annual Meeting, to be held at Chalfonte-Haddon Hall, Atlantic City, June 26 to 30, inclusive, 1939, will feature a number of interesting technical sessions. Committee E-6 on Papers and Publications has made preliminary arrangements for the program and the topics which undoubtedy will develop include the following: Symposiums on low-temperature applications, paint testing, water, and shear testing of soils. Other papers and reports will cover creep testing of steel, laboratory corrosion testing, die casting, bleeding in concrete, mineral aggregates, asphalts, calibrated glass apparatus, spectrographic analysis, radiography, and many other subjects.

During the week of the annual meeting, the Fifth Exhibit of Testing Apparatus and Related Equipment will also be in progress. Announcements are being sent to companies in the apparatus, instruments, and related fields and a number of companies have already indicated their intention to take part. The exhibit will be featured also by special displays arranged by various committees of the Society and it is anticipated that some university, government and company laboratories will be invited to participate as in former years. These research displays have added a great deal to the educational atmosphere desirable in the exhibit and have been of much interest to many of the members.

Another feature of the meeting will be the Second Photographic Competition. A special committee is being appointed to develop the plans for this but in the meantime all members of the Society, committee members, and others interested are invited to keep the photographic competition in mind and if they have any special photographs or prints in the field of testing or relating to engineering materials and research, they may wish to earmark these for possible entry in the exhibition.

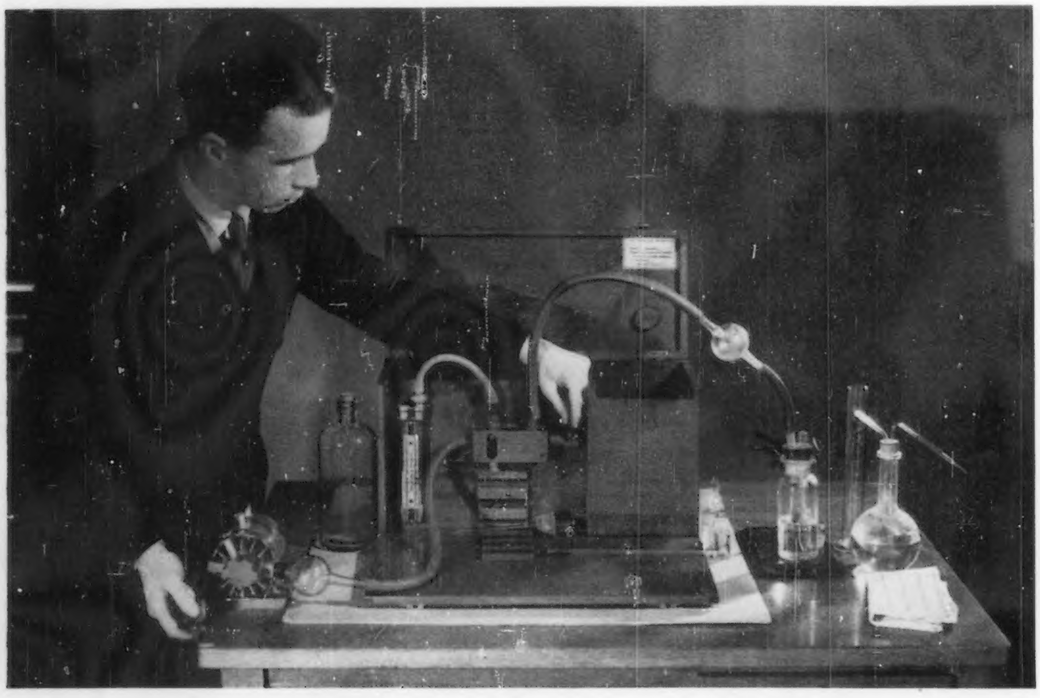
J. R. Townsend on Executive Committee

J. R. TOWNSEND, Materials Standards Engineer, Bell Telephone Laboratories, Inc., New York City, has been appointed a member of the Executive Committee of the Society, taking the place vacated by Allen Rogers, who resigned in September because of ill health and whose death is announced in this BULLETIN.

Mr. Townsend, whose term will expire in June, 1940, has been extremely active in many fields of work of the Society. He is chairman of Committee B-6 on Die-Cast Metals and Alloys, a member of Committee E-10 on Standards, and has participated in the work of other groups, including Committees B-2 on Non-Ferrous Metals and Alloys, A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, E-1 on Methods of Testing (chairman of the Section on Indentation Hardness) and the Research Committee on Fatigue of Metals. A member of the New York District Committee, he was recently elected chairman of this group.

In 1930 he was awarded (jointly with W. A. Straw and C. H. Davis) the A.S.T.M. Charles B. Dudley Medal for the outstanding paper on "Physical Properties and Methods of Test for Some Sheet Non-Ferrous Metals."

Born in Baltimore, Md., Mr. Townsend attended Baltimore City College and Brooklyn Polytechnic Institute. Beginning in 1919 he has been a member of the Technical Staff of the Western Electric Co., and since 1925 in his present position. He is the author of numerous technical papers and reports. In addition to A.S.T.M. he is active in the work of the American Society for Metals, American Welding Society, American Society of Mechanical Engineers, American Ceramic Society and American Standards Association.



"Air Sampling" photograph by K. L. Herrmann and R. C. Stratton, Travelers Insurance Co., awarded honorable mention in 1938 photographic exhibition.

Non-Destructive Testing in the United States of America[1]

By H. H. Lester,[2] R. L. Sanford[3] and N. L. Mochel[4]

EDITOR'S NOTE.—An invitation to the Society from the British Joint Committee on Materials and Their Testing, to arrange for papers on non-destructive testing, so that American thoughts and practices would be covered in the meeting in London, as well as the British and Continental Europe viewpoints, resulted in assigning this paper to a committee comprising H. H. Lester, R. L. Sanford and N. L. Mochel, Chairman. The section on Radiographic Methods was prepared largely by Dr. Lester; the one on Magnetic and Electrical Methods by Mr. Sanford; and the part on Acoustical and General Methods by Mr. Mochel; but in each case there were suggestions, cooperation, and review by the other members of the committee.

Certain considerations in BULLETIN publication make it desirable to change the order of the parts of the paper as presented at the meeting, so that this issue covers the material on magnetic, electrical, acoustical and general methods; the part on radiographic methods will appear in the January BULLETIN.

THE decision of the British Joint Committee on Materials and Their Testing to hold a discussion on the subject of non-destructive testing would appear to be further evidence of a growing world-wide interest in methods that will permit of more completely testing the actual material or construction that man intends to use.

Such growing interest would almost imply that non-destructive testing is something quite new. While it is true that some methods in use are of recent development, and there is much activity in the development of new methods in many fields of industrial activity, it is also true that many of our present methods of non-destructive testing have been in restricted use for many years, but only recently has there been any widespread adoption of some of them. Industry is often very slow in adopting some of these more searching tests, and there are obvious reasons for this condition.

Usually, non-destructive test methods are originally developed for some rather special or limited application. Naturally, some methods never get beyond that first field of use. Others are of such nature that they quickly pass from a restricted field of use into broad or general adoption. Other methods may be in existence for years, and used but little or not at all, only to be picked up and used widely when design and operating conditions, such as speed, pressures and temperatures, require or justify such practices.

Once these methods become developed and known, there is a moral responsibility on the part of the manufacturer or consumer to have these methods at hand, ready to use when the application involved justifies their use, whether it be a matter of safety to life or property, the integrity of product, or purely a matter of economy.

Some non-destructive testing methods have had an important part to play in the success that has attended certain engineering activities. The reliability of aviation engines and parts is in no small measure due to magnetic test methods, that have prevented faulty parts from getting into service. Jacobus (1)[5] has recently remarked that "radiographing was the turning point in the development of sound and reliable welding."

In the United States, the term "non-destructive testing" has no fixed or narrow interpretation. It is rather broadly, even loosely, applied, ranging from very simple practical or empirical tests on the one hand to those of more complicated or technical nature on the other. In general, the use of the term involves the application of some over-all test to the material or part actually to be used, to completely or partially determine its sufficiency for the intended service. It must test the material itself, not a sample of it. Sufficiency, as used above, may be a matter of soundness, tightness, freedom from injurious defect, freedom from harmful internal stresses, or a matter of proper hardness or desired structure, or any other feature upon which assurance is desired.

The term "nondestructive" of course implies that nothing is destroyed. This must be qualified to the extent that some tests, that have every right to be considered non-destructive tests, may bring destruction to faulty material or parts, but have no effect whatsoever on satisfactory material. After all, faulty material is also rejected outright by other tests of a purely non-destructive nature, so that the net result is the same. Some tests of course leave rejected material available for correction.

The paper is divided into three parts, as requested by the British Joint Committee, as follows:

Magnetic and Electrical Methods
Acoustical and General Methods
Radiographic Methods

Magnetic and Electrical Methods

MAGNETIC METHODS

In the United States, the term "magnetic analysis" has been adopted to denote the use of magnetic methods for the investigation and inspection of materials with respect to properties other than magnetic, as distinguished from tests made for the sole purpose of determining magnetic properties. The idea of taking magnetic characteristics as criteria of mechanical quality is not new. As early as 1868, S. M. Saxby, Esq., in a paper (2) before the Institution of Naval Architects described experiments in which he was able to detect certain defects and inhomogeneities in specimens of iron, including gun barrels, by means of a magnetic compass. Ten years later Anaxamander Herring of Cohoes, N. Y., applied for a United States patent[6] for "Improvement in Ascertaining the Density and Tensile Strength of Iron and Steel by Magnetism" which was granted in 1879. His "improvement" constituted an extension of the principles used by Saxby and also employed a compass needle as the indicating element. William Metcalf (3) also considered the possibility of utilizing magnetic properties as an index of quality and read a paper before the American Institute of

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[1] Presented at a meeting in London, England, November 25, 1938, arranged by the British Joint Committee on Materials and Their Testing and held under the auspices of the British Institution of Electrical Engineers.

[2] Senior Physicist, Watertown Arsenal, Watertown, Mass.

[3] Chief, Magnetic Section, National Bureau of Standards, Washington, D. C.

[4] Metallurgical Engineer, Westinghouse Electric and Manufacturing Co., Philadelphia, Pa.

[5] The numbers in parentheses refer to a list of references appended to this paper, see p. 13.

[6] U. S. Patent No. 213,197, March 11, 1879.

Mining Engineers in 1880 entitled "Can the Magnetism of Iron and Steel be Used to Determine Their Physical Properties?" These early investigators were greatly hampered by imperfect knowledge not only with respect to magnetic phenomena but also with regard to the structure and physical characteristics of iron and steel. It is only in relatively recent years that the fundamental principles have become sufficiently well understood to permit their practical application in industry.

The modern development of magnetic analysis in the United States dates back to the pioneer work of Charles W. Burrows and Frank P. Fahy, who, in the latter part of 1911, undertook at the National Bureau of Standards an investigation of the magnetic and mechanical properties of spring steel under the joint sponsorship of the Bureau and the Pennsylvania Railroad. This investigation was later extended to cover the applicability of magnetic analysis to various other forms of steel products and was carried on over a period of about five years. The results were published in the *Proceedings* of the American Society for Testing Materials in 1919 (4).

In 1918 the American Society for Testing Materials established Committee A-8 on Magnetic Analysis for the purpose of fostering the development and application of magnetic analysis in industry and of carrying out fundamental researches of a general nature. The committee served primarily as a clearing house for the interchange of ideas and experiences among its members, many of whom carried out individual investigations on various phases of the subject. This committee was recently merged with Committee A-6 on Magnetic Properties and now functions as a subcommittee of Committee A-6.

Since 1916 when Burrows published a summary (5) of previous work on the correlation of magnetic and mechanical properties of magnetic materials, scores of papers on various phases of the subject have appeared in the technical literature. In the light of present knowledge, it appears improbable that a universal relationship exists between the two sets of properties regardless of material. On the other hand, no exception has been recorded to the general principle that, for material of the same composition, two specimens having identical magnetic properties will be found to have the same mechanical characteristics and, further, that any treatment which alters the mechanical properties to a measurable extent at the same time changes the magnetic properties though not necessarily to a corresponding degree. The nature of the changes is generally similar for different types of material, but this is not a universal rule as notable exceptions have been observed. Furthermore, certain secondary effects, particularly mechanical strain, exert an influence on magnetic properties out of all proportion to their effect on mechanical properties. These secondary effects constitute one of the major difficulties in the way of practical applications or the establishment of definite quantitative relationships. It must be recognized, therefore, that there are certain limits to the applicability of magnetic analysis imposed on the one hand by the physical principles involved and on the other hand by experimental difficulties. These limits cannot be stated definitely because the physical principles are not well understood and experimental technique is continually being improved. It may be remarked that the development and application of magnetic analysis has been retarded no less by the extravagant claims of over-optimistic enthusiasts than by the doubts of over-cautious skeptics.

Since it does not appear feasible to deduce the mechanical properties of a given piece of material directly from data on its magnetic properties, it becomes necessary in practice to compare its magnetic properties with those of another piece known to have the requisite mechanical properties which serves as a standard of quality. The amount of difference which can be tolerated is determined by experiment. Various methods of making such comparisons have been devised, several of which have been found to be commercially practicable and are in daily use. As a rule, only one magnetic characteristic is taken as the basis of comparison. This may be simply the magnetic permeability, some quantity such as residual induction or coercive force derived from the hysteresis loop or the wave form of an alternating induced voltage as determined by the shape of the hysteresis loop. Various inhomogeneities and flaws are also detected by abnormal magnetic leakage which they produce under proper experimental conditions. Methods have also been developed for measuring the thickness of nickel coatings on nonmagnetic base metal, and of nonmagnetic coatings on magnetic base metals. It is difficult to estimate with any reasonable degree of accuracy how extensively the methods of magnetic analysis are employed at the present time. Several suggested methods have either been found impracticable under commercial conditions or have not been developed to meet shop conditions. On the other hand, some of the most useful methods have never been described in the technical literature. Perhaps an idea of the general utility of magnetic analysis may be given by a brief description of a few typical examples.

One of the earliest successful applications of magnetic analysis is an apparatus for testing steam turbine bucket wheel forgings developed by the General Electric Co. with the collaboration of Dr. Burrows (6). One form of this apparatus is shown in Fig. 1. The forging under test is

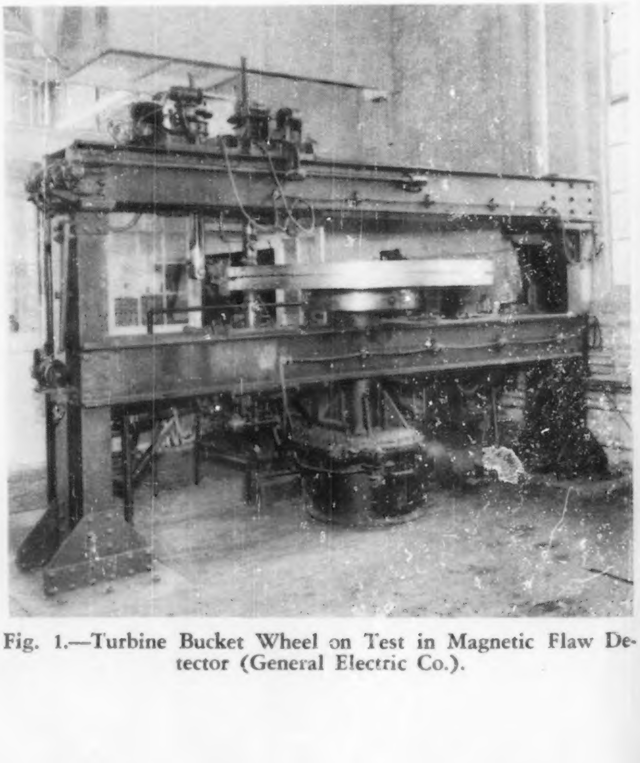


Fig. 1.—Turbine Bucket Wheel on Test in Magnetic Flaw Detector (General Electric Co.).

slowly rotated on its own axis between the poles of a d.c. electromagnet which can be adjusted to any given position on the radius of the circular forging. The magnetic flux traverses the air gap between the pole tips in which air gap the disk is rotated. Variations in magnetic quality of the material in this air gap are indicated by an instrument connected to differential test coils mounted on the poles of the electromagnet.

In the paper describing this apparatus (6), it is stated that forgings in which defects are indicated by the magnetic test are always given a visual examination even though they may be destroyed in taking the necessary specimens. Furthermore, the statement is made that "It is a significant fact that we have never had a magnetic indication of trouble without finding an adequate cause." Although rejections are very few, it is obviously very important that no defective piece be used in a finished turbine, since failures in service generally result in serious damage or even loss of life. The magnetic testing apparatus has been in constant use over a period of several years.

Although direct-current methods are usually best for fundamental investigations, it has been found that there are several advantages to be gained by using alternating currents for routine inspection. It is possible, for instance, to obtain readings which depend upon the shape of the hysteresis loop which often is a better indication of structural characteristics than simple permeability.

One company specializes in the inspection of steel and steel products by magnetic methods. Their apparatus (7) employs alternating current and operates on the comparison principle in which the material is compared magnetically with a standard of known quality. The method is best adapted to material of uniform section in relatively long lengths such as bars, tubes, sheet and strips, but has also been applied to such products as bolts for aircraft and shafts for golf clubs.

In order to guarantee satisfactory and continuous operation and the incorporation of later improvements which are continually being developed, this company leases its apparatus to customers rather than selling outright. In its original form, the apparatus consisted of two exactly similar magnetizing coils within which were mounted search coils, also alike, and connected in series, opposing. A suitable standard was inserted in one set of coils and the material under test was passed through the other set. The wave form of the difference in electromotive force induced in the two search coils was indicated by an oscillograph. The wave forms thus observed were then interpreted as indicative of differences between the properties or condition of the test material and the standard. Later improvements include the replacement of the oscillograph by indicating instruments and signal lamps which improved the precision of the indications and speed of operation; the addition of filter circuits for differentiating between the various harmonics; and the substitution of electric standards for the original standard coil arrangement which had to be water cooled to avoid undesirable temperature effects.

The apparatus, Fig. 2, is used to check bar stock for analysis, mechanical defects such as cracks, seams, and deep slivers, excessive segregations and uniformity of structure as affected by heat treatment. Pipe and tubing are also inspected for quality of welds and uniformity of heat treatment.

The following table given by the Magnetic Analysis Corp. shows the progressive increase in the quantity of bar stock inspected with their apparatus during the past few years:

Total Tonnage of Bar Stock Inspected

Year	Tons
1932	2000
1933	8000
1934	21000
1935	46000
1936	63000
1937	87000

On account of the great diversity of products and manufacturing conditions which have to be met, no one type of apparatus is universally applicable. Each inspection problem must be considered individually in the light of the nature of the product and the requirements as to structure, freedom from defects and manufacturing processes. As examples of different kinds of problems which have been met in practice, several types of apparatus may be cited. One company (8) has established a regular procedure for the study of new problems in which the material is magnetized with a suitable magnetizing winding using alternating current. The electromotive force induced in differential test coils mounted within the magnetizing winding is fed into a harmonic analyzer by

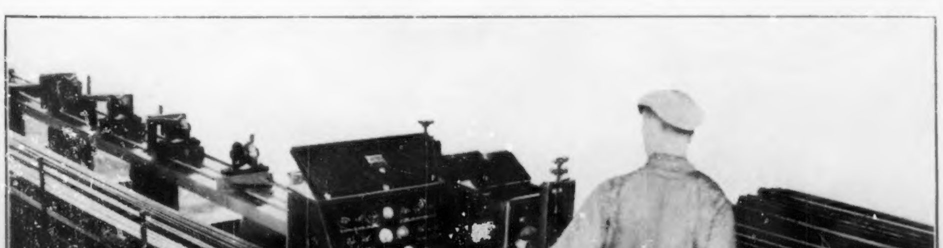


Fig. 2.—Testing Bar Stock by Magnetic Analysis (Magnetic Analysis Corp.).

which the magnitudes of the harmonics are measured. The phase relations of harmonics are observed by means of an oscillograph. By a study of the harmonics and their phase relations, the type of apparatus required to meet the specific requirements is determined.

In this way apparatus was developed for the detection of defects in small-size boiler tubing, inhomogeneities in magnetic strip material and imperfect lap welds in steel tubing. This equipment satisfactorily located defects not visible to the eye and with automatic control very rapid inspection is accomplished.

By using current of high frequency, derived from a vacuum tube oscillator, flaws in copper tubing are detected by another device.

A somewhat different type of problem was solved by apparatus which determines the amount of magnetic inclusions in asbestos fiber used for insulating copper conductors. The instrument is calibrated in terms of the percentage of iron in the form of Fe_3O_4 contained in a 10-g. specimen of the fiber. The apparatus can also be used for determining magnetic impurities in other insulating materials such as sand, mica, glass, etc.

The apparatus shown in Fig. 3 is used for detecting the presence of iron objects in various nonmetallic materials or baled scrap in which such iron would be objectionable. The presence of iron is made known by a visual or audible signal.

A prominent manufacturer of razor blades employs a magnetic method for the continuous control of heat-treating operations. According to the patent[7], the apparatus can be used to control either the hardening or tempering operation or both. Strip steel is heat treated by a continuous process in which the steel is fed in turn through an induction furnace, a quenching device, a magnetizing coil, another induction furnace and another magnetizing coil. Within each of the magnetizing coils there is a search coil connected in series-opposition with a similar coil mounted within an auxiliary magnetizing coil. Suitable standards are located in the auxiliary coils and photoelectric relays operated by the differential voltage induced in the search coils control the current in the furnaces.

One magnetic method of inspection (9) which has found wide application in the United States is generally known by the trade name "Magnaflux." This method was originally discovered by Hoke, and further developed and applied by de Forest, McCune, and their associates. By this method, cracks, seams and imperfect welds are indicated on the surface of magnetized specimens by the adherence of finely divided magnetic powder applied either dry or suspended in a suitable liquid.

The best method of magnetization depends upon the form and size of the piece to be inspected and the probable location of suspected defects. A common method is by means of a suitable electromagnet. Abnormal leakage from the surface of the specimen brought about by the presence of a defect produces magnetic poles to which the magnetic powder is attracted, thus outlining the defect. Best indications are obtained when the direction of magnetization is at right angles to that of the crack or other defect. Considerable ingenuity is often required in producing the right degree and direction of magnetization. The correct interpretation of the patterns also calls for the exercise of judgment based on experience. In some instances, the use of an electromagnet for magnetizing the specimen is impracticable. Recourse is then had to direct magnetization either by means of conductors wrapped upon the piece or by sending current through the piece itself. This method is particularly suitable for detecting longitudinal defects in specimens such as rods or tubes.

In one plant railway motor shafting made from heat-treated S.A.E. No. 3135 nickel-chromium steel bars is being tested by the Magnaflux method. It has been found that a direct current arc-welding unit is a very convenient means for magnetizing bars up to $5\frac{1}{2}$ in. in diameter, by passing current through the shaft from end to end for a period not over 10 sec. The residual magnetization has given an excellent indication of any longitudinal imperfections at or near the surface of the shafts.

The Magnaflux method has a wide use in this country. It is greatly relied upon in the inspection of parts of aviation engines and airplane fittings (10). Automobile parts, boiler tubes, tools and other ferrous metal products are being examined. More recently welded structures of many kinds have been examined (11). Alloy steel rotor forgings for steam turbines are examined for thermal cracks. Turbine blades or buckets have long been tested by this method. The "wet" method is used for the examination of forged and machined blades during manufacture and the "dry dust" method has more recently been applied to the testing of blades in position in the turbine rotors and cylinders during routine inspection periods. Fatigue fractures in progress, that have always been very difficult to find, are readily revealed by this method.

An example of defects revealed by the Magnaflux method is shown by Fig. 4.

Magnetic methods are used not only for checking the quality of materials and parts but also for determining various quantities whose measurement would otherwise entail some damage to the material tested. For example, the measurement of the thickness of coatings of enamel, paint, nickel, tin and the like on metal bases by mechanical or chemical means usually results in damage to the surface or even in some cases destruction of

[7] U. S. Patent No. 2,041,029, May 19, 1936.

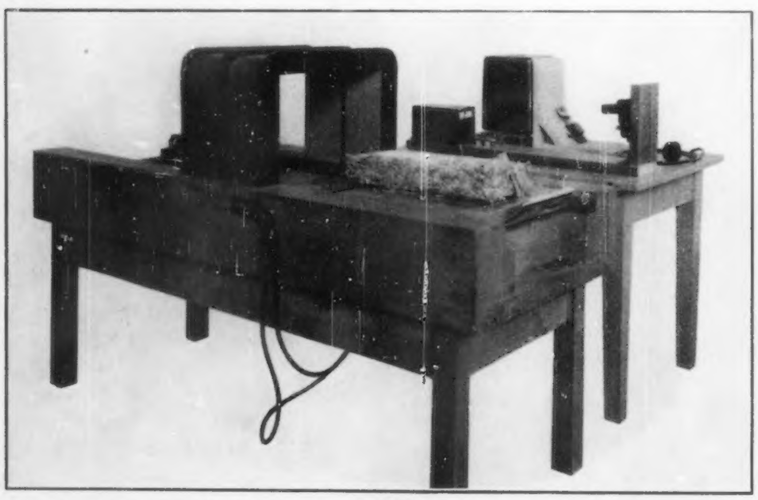
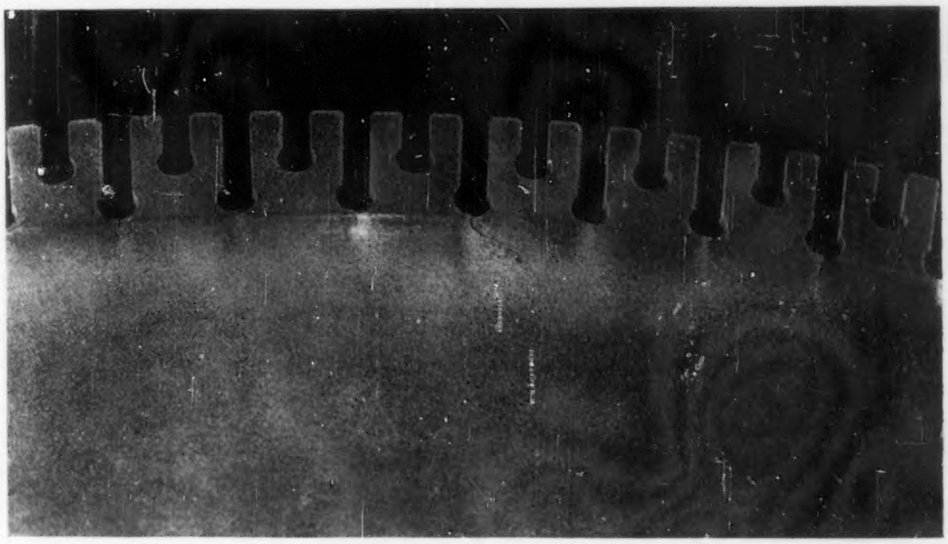


Fig. 3.—Apparatus for Detecting Iron in Nonmagnetic Materials (General Electric Co.).

Fig. 4.—Cracks in Turbine Bucket Wheel Forging Revealed by Magnaflux Method (National Bureau of Standards).



the piece itself. At least two commercially practical nondestructive methods are in use.

An electrical enamel thickness gage (12), shown in Fig. 5, is used to measure the thickness of enamel or paint on a flat steel surface. It consists of a gage head and indicating unit and operates on a 110-v., 60-cycle power supply. The reluctance of the magnetic circuit of the gage head when placed on a coated steel surface varies with the thickness of the coating. This reluctance in turn affects the inductance of the coil in the gage head which is compared by a bridge arrangement with the inductance of a similar coil in whose magnetic circuit there is an adjustable gap. The indicator is a sensitive electrical instrument connected as the detector in the bridge circuit through a copper oxide rectifier. By means

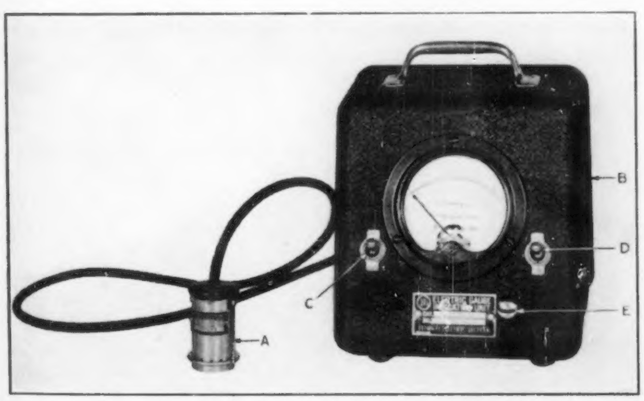


Fig. 5.—Electric Enamel Thickness Gage (General Electric Co.).

of suitable thickness standards the indicator is calibrated to read thickness directly in thousandths of an inch. The instrument is useful chiefly for measuring coatings at least several thousandths of an inch thick.

A somewhat different principle is utilized in a type of instrument recently developed at the National Bureau of Standards. The instrument is a portable spring balance arranged to measure the force required to detach a permanent magnet from the surface under test. One form of the instrument is designed to measure the thickness of nickel coatings on nonmagnetic base metals (13) and the other, which employs a smaller magnet and a stiffer spring (14) is used to measure the thickness of nonmagnetic coatings on iron or steel. The force required to detach the magnet from a nickel coating increases with the thickness of the coating and is proportional to the thickness up to about 0.001 in. For nonmagnetic coatings on a magnetic base, the force decreases with the thickness. Both types of magnetic balance have been found sufficiently reliable for use under commercial conditions. They are particularly valuable for determining local variations in thickness of coating. The instrument with cover removed is shown in Fig. 6.

Regarding the practice of testing the magnetic quality of electrical sheets, the standard method of testing electrical steels (core materials) is the Epstein test which requires shearing into small strips and consequently is destructive of

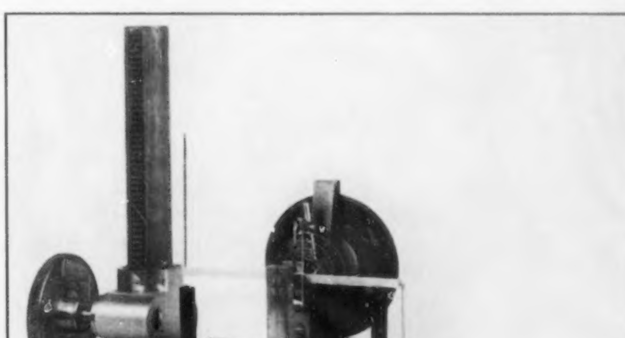


Fig. 6.—Magnetic Balance for Measuring Thickness of Coatings on Metal (National Bureau of Standards)

material. Several steel manufacturers have recently developed a method of testing complete sheets approximately 30 by 108 in., quite satisfactorily. The chief objection to this test is that it tests for losses only and with the flux flowing only in the direction of rolling, whereas in machines the flux flows in various directions relative to rolling. By making a number of tests on the sheet tester and then shearing these sheets and testing by the conventional method, it is possible to obtain a satisfactory correlation so far as losses are concerned. This test is being applied only to the poorer grades of material where the limits are not critical and has not been applied as yet to the higher grade (lower loss) materials. Tests for other qualities such as permeability and ductility still require destruction of sheets but require less material and in addition are often waived except for periodic spot tests.

ELECTRICAL METHODS

Electric methods for nondestructive testing are not so numerous as those based upon magnetic properties. Perhaps the outstanding example of an electrical method is the one for detecting flaws in railway rails developed at the suggestion of the American Railway Engineering Association by the late Elmer A. Sperry (15).

In its present form, the Sperry apparatus is built into a

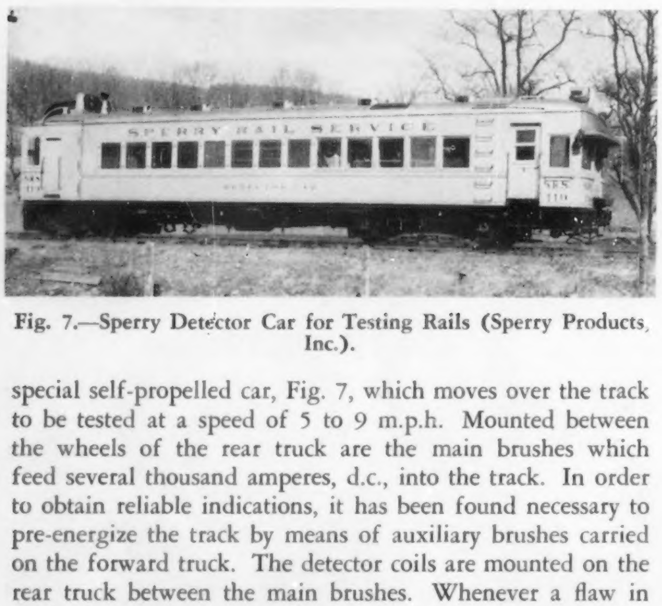


Fig. 7.—Sperry Detector Car for Testing Rails (Sperry Products, Inc.).

special self-propelled car, Fig. 7, which moves over the track to be tested at a speed of 5 to 9 m.p.h. Mounted between the wheels of the rear truck are the main brushes which feed several thousand amperes, d.c., into the track. In order to obtain reliable indications, it has been found necessary to pre-energize the track by means of auxiliary brushes carried on the forward truck. The detector coils are mounted on the rear truck between the main brushes. Whenever a flaw in the rail causes a deviation in the direction of the current in the rail, a corresponding deviation in the direction of the magnetic field around the rail is produced. This induces currents in the detector coils which are amplified so as to operate relays carrying pens on a moving tape. At the same time, a paint gun ejects a spot of paint on the rail at the point of defect. The record table and tape are shown in Fig. 8.

When a flaw is thus located, the car is stopped and the extent of the flaw is determined by a drop-of-potential method using portable apparatus as shown in Fig. 9. From the result of this measurement it can be decided whether or not the defect is sufficiently serious to require the immediate removal of the rail. The defects commonly found are transverse fissures, compound fissures, horizontal split heads and vertical split heads.

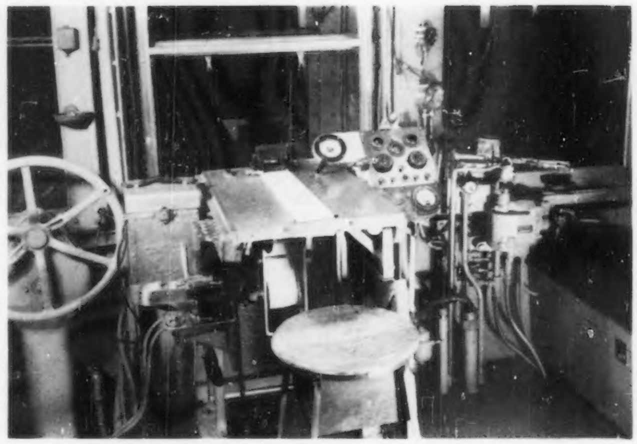


Fig. 8.—Record Table and Tape, Sperry Detector Car.

The practical value of this testing method is demonstrated by the fact that during the seven-year period 1931 to 1937 inclusive, more than 185,000 defective rails were discovered in approximately 355,000 miles of track inspected.

The Ronay (16) Arcronograph, Fig. 10, is an apparatus which records variations in the voltage of the arc during the process of electric-arc welding. It has been found that the general quality of a weld and the location of defects such as voids, cold-shuts and imperfect fusion can be predicted from the graphic records obtained by the Arcronograph. The recording instrument is connected in the plate circuit of an electron tube whose grid potential depends upon the voltage across the arc. The characteristic of the tube is such that it is most sensitive in the upper part of the voltage range which is the most important part. The instrument can be operated on either direct or alternating current and is used not only for checking the quality of important welds but also in connection with the training and rating of welders and for testing the quality of electrodes.

Fig. 9.—Hand Test on Rail by Sperry Method.

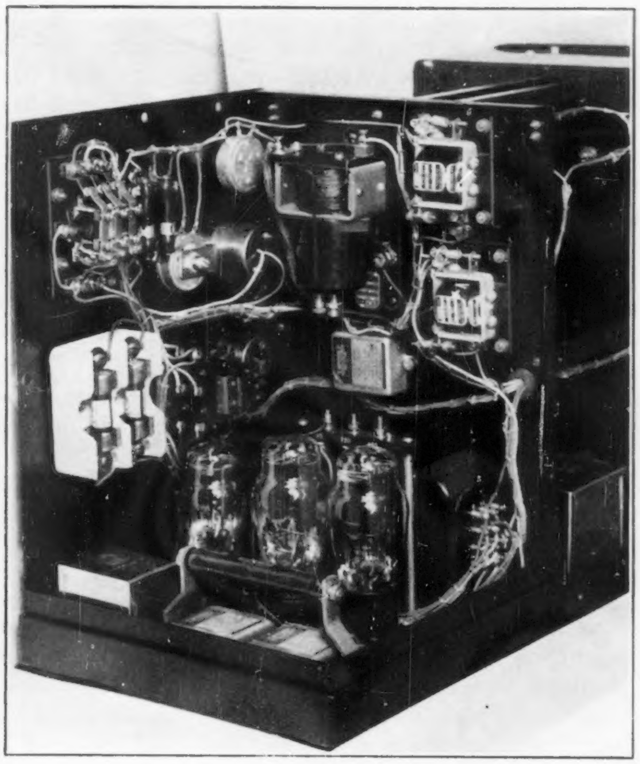


Fig. 10.—Ronay Arcronograph (Rubicon Co.).

Acoustical and General Methods

There are many examples of non-destructive testing in use in the United States, other than the radiographic, magnetic and electrical tests already discussed. No attempt can be made to offer anything like a complete list of such tests. In the space available, reference can only be made to several types or classes of tests, to indicate the extent and general nature of such practices.

VISION

It may appear somewhat unnecessary to list vision as a test measure in this presentation. With the development of some newer test practices, and especially the more general adoption of radiographic methods, there has been noted a tendency to forget that careful examination by eye, aided optically or otherwise, by experienced, trained personnel, is indispensable in all engineering activities. It should be remembered that many non-destructive test methods merely aid the eye, to make it see better.

In many plants, one finds portable micrographic apparatus, often equipped with photographic means, for the examination of defects, questionable areas, and variations in structure in large forgings or castings from which even small specimens cannot be removed.

Hardness Tests

Hardness testing is often considered as destructive testing, but actually it is widely applied as a non-destructive test, for the control of heat-treating operations, and to assure satisfactory physical characteristics in materials. Care must of course be exercised as to the size, the location and the nature of the impression or markings left by the test. The test may be made on surfaces having stock provided for machining, and the impression and all practical effects of it are thus removed. A boss, button or other protuberance may be provided on drop forgings, die castings, castings, etc., on which the test may be made, and the impression then removed or allowed to remain. Often the test is applied to the finished part and the impression or mark allowed to remain in the part. Unwise choice of test method has at times resulted in cracks—in hardened metal, for example—spreading from the impression. Improper location of the impression has at times resulted in fatigue failures in service. There are, however, many hardness test methods available for practical use, and careful selection can be made for nearly any purpose.

One extreme example of such selection may be cited. The question of uniformity of hardness of journals and crank pins in finish-machined crankshafts for high-speed Diesel engines had arisen. It was desired to know definitely that pins and journals were of uniform hardness, around each pin and journal, and from one to the other along the shaft. The impression left by many hardness testers was very objectionable, some quite dangerous. Moreover, it was very difficult to accommodate the shafts in the testing machines. The problem was solved by using the Herbert pendulum and swinging it as desired on the shaft pins and journals. The resulting shallow impressions were entirely acceptable on these surfaces.

PROOF TESTS

There are a great many so-called proof tests in use today in this country. Some are looked upon as quite old fashioned, but many are quite practical and valuable.

There is, for example, the proof testing of chain for all purposes, of eyebolts, of cables, and other gear and parts for lifting purposes. Usually a proof load is applied that is well above the rated service loads. In the case of welded wrought iron chain, the proof load is usually high enough actually to deform the links.

An impact proof test is used for carbon steel and alloy steel axles, shafts and other forgings for locomotives and cars. Practice varies somewhat, but in general the forging is placed across supports and subjected to the fall of a tup of varying weight and from varying heights of fall (17).

The rules of the American Bureau of Shipping and Lloyds' Register of Shipping require that castings for hulls and anchors shall be subjected to a drop test onto a hard surface, and later that they be slung clear of the ground and well hammered all over with a heavy sledge hammer to test the soundness of the material.

Hardened parts such as knife edges, bearing blocks and buttons, are often loaded in compression beyond that to be encountered in service, to guard against internal cracks, high internal stresses, soft interiors, or other objectionable conditions. Such tests are usually supplementary to magnetic tests for surface cracks.

TESTS TO DETERMINE CRACKS

Although the Magnaflux, or some other type of magnetic or electrical test, is being widely adopted for the determination of surface or near-surface cracks in ferrous materials, some of the older and perhaps cruder tests are still in limited use.

In one such method, the material or part is covered with oil, which penetrates any cracks; next the oil is carefully wiped from the surface, and the surface then coated with

whiting. The part may be allowed to remain at rest, and in time retained oil in the cracks will produce discolored streaks in the whiting. Or the part may be struck with sharp blows, or rotated slowly, to force retained oil out of the cracks and thus discolor the coating.

Large coiled springs are at times smooth steam-sand-blasted, and then immersed in kerosine for several hours, then withdrawn and wiped clean of all surface oil. If cracks are present, in a short time oil which has penetrated into the cracks will seep out and show a darkened line on the "satin" finished surface.

So-called "buffalo" knives, for meat cutting, are tested by passing the blades between three rollers which bend the blades a known amount. The amount of bending is so adjusted that a sound blade will come through the rolls and retain its shape, but should cracks be present actual breaking of the blade will always result.

TESTING OF FILES

File makers make use of two tests that do no harm to satisfactory material but invariably ruin defective products.

In the so-called "ring" test, the file is gripped by the tang, and struck sharply on its edge against a standard steel block. A good file rings true, but a cracked file will fall in pieces.

In the decarbonization test, a steel specimen having a Rockwell hardness, "C" scale, usually of 57 to 58, is drawn rapidly down over the teeth of the file. A standard file is unmarked, but a soft file develops a tell-tale marking.

TESTING OF HAND-SAW BLADES

One of the oldest reported non-destructive tests is still in use. Many years ago we received in this country from abroad, a brief article that was reputed to be the oldest known account of heat treating, the preparation, hardening and proof testing of one of the old famed swords of the Near East. It will be recalled that two tests were required, the first as to its cutting ability, and the second being that "the blade may be bent round about the body of a man and break not." It is still the practice to bend finished hand saws until the two ends of the blade meet, without failure and without permanent set.

TESTS ON COILED SPRINGS

The ordinary tension, compression, bending and torsion tests on springs to determine their suitability and scale are in a sense non-destructive tests. In addition, springs are often tested to determine their freedom from any tendency toward taking a permanent set by compressing or stretching beyond their rated deflection, and even repeating this a number of times. At times, rapidly repeated compression tests have been made on springs for a greater number of reversals than they will actually get in service, to assure against objectionable permanent set and fatigue failures. As referred to elsewhere in this article, the Magnaflux test is applied to important springs, as well as the oil-immersion test.

TESTS ON TURBINE ROTOR FORGINGS

Occasionally one finds a number of non-destructive tests applied to a single article. Large forgings for the rotors of steam turbines are a good example. In addition to the usual analyses and physical tests, which are sample tests, non-destructive tests as follows are in use:

Sulfur prints are made at the end surfaces to determine center segregation, and to locate the "metallurgical axis" of the forging which is considered quite important to some builders. Such prints are also made at end faces and around the outside of the main body, especially at the largest diameters, to determine freedom from ingot corner segregation.

Magnetic tests, usually by the Magnaflux dry-dust method, are made over the "break down" areas, that is, from the outside edge of the main body down and beyond the junction with the shaft portion. The test is also applied between stage disks, when they are integral with the shaft. The test is made to guard against fine thermal cracks or similar defects.

A smoothly finished hole is bored through the axis of the forging, and the walls of this hole carefully examined with a borescope, to determine complete freedom from injurious defects of any nature.

Then there is applied a stability test, to determine that the rotor will operate smoothly, without distortion and resulting vibration, when put in service. The rotor is put in a special lathe, and surrounded with a suitable heating furnace. Slowly revolving the rotor, it is gradually heated to 50 or 100 F. above the expected operating temperature. Truth readings are taken at several, usually five, selected locations along the length of the forging, during the heating, holding, and cooling periods. Tolerances of allowable distortions, and differences between final hot and final cold readings, are agreed upon.

Finally there are overspeed tests, both cold and hot, to approximately 20 per cent above normal operating speeds.

DRILLING TESTS

Reference was made above to the inspection bore in rotor forgings. Such inspection bores are used in many other forgings. As a matter of fact, good practice rather dictates the use of such holes in all "large" forgings.

The rules of the American Bureau of Shipping require the drilling of holes in steel castings, at locations of questionable soundness, to determine freedom from defect. The practice is in general use in other fields as well, to explore known defects, to determine the presence of defects, to determine wall thickness, etc. The holes are subsequently plugged, and often the plugs are welded.

SPARK TESTING

This rather old practice is still in active use in some places. An experienced operator touches a grinding wheel to the ends of all bars of steel in a shipment, before acceptance, and observing the nature of the spark, determines whether improper material is mixed into the shipment.

ETCHING TESTS

Some etching tests, other than the sulfur prints already referred to, are in use as nondestructive tests.

Spotting tests with various acids or other reagents having known reaction on materials are often used to separate parts, or weed out foreign material.

PRESSURE TESTS

There are a great many pressure tests that must rightly be looked upon as nondestructive tests. Some are purely to determine tightness, freedom from leakage. Others are for

that purpose, and in addition a sort of proof testing of the material or structure itself.

In pressure tests, the pressure used is determined in different ways. In many cases, it is some function of the expected operating pressure, such as $1\frac{1}{2}$ times the service pressure. In others, the pressure is determined from a formula that will stress the material to some percentage of the yield point or tensile strength. In others it is purely an arbitrary pressure that is high enough to reveal leaks or burst faulty material, and do no harm to normal material.

For high-temperature, high-pressure steam service, the older practice of hydraulic testing with water at room temperature is being supplemented with steam tests at operating pressures and temperatures. Steam pressure boosters are now available for such testing.

Pressure tests vary in nature, depending of course upon the application at hand. Water, steam and various oils are used. Hot oil tests are often used, with care being taken that proper oil of sufficiently high flash point is used. Air is sometimes used with the part immersed in water, and soundness judged by air bubbles. Or soap suds may be placed on one side of a wall and air on the other, soap bubbles indicating leaks. Vessels to contain gases may be tested under pressure with that gas, and a chemical indicator used on the outside. Vacuum apparatus is tested under vacuum conditions.

Very often, vessels, pipes, etc., are struck sharp blows with a specified weight of hammer, while subjected to the specified pressure tests.

HAMMERING TESTS

Reference has already been made to hammering tests on steel castings for ship hulls and anchors. Hammer tests are also made on pipe, on forgings, on welded construction, and on forge-welded construction. Repeated hammering tests are at times used to disclose high internal stresses in cylindrical parts, especially centrifugally cast cylinders.

STETHOSCOPE TESTS

Kinzel and his associates (18) at the Union Carbide and Carbon Research Laboratories have made extensive use of the stethoscope in the examination of welded tanks, pipes, vessels, etc. It is claimed that the addition of the stethoscope to the older method of striking the part and listening with the unaided ear has made this a reliable test method.

TESTING OF PORCELAIN AND GLASS

Non-destructive tests are applied in many cases to nonmetallic materials. The testing of porcelain insulators and transmission line fittings to make sure that they will perform under service conditions is one example. In one plant, all high voltage porcelain parts designed for service above 6.6 kv. are given a so-called routine flashover test. This test consists of setting the porcelain parts on a flat metal surface and the other terminal is usually set into the inside. In most of the routine tests the insulators are run over a moving conveyor which facilitates handling large quantities. The test is made with a 60-cycle voltage and the flashover is continuous for a period of 3 to 5 min. The continuous flashover is obtained by using a transformer with resistance in the primary so that as soon as the arc forms, the voltage decreases and the arc goes out.

Fig. 11.—Glass Strain Detector (The Polaroid Co.).

In addition to the flashover test, routine mechanical tests are made on all suspension insulators after assembly with metal parts. Usually they are tested to about 40 per cent of the guaranteed strength. Some are tested in cantilever or torsion, or compression. Most of these approach the expected maximum service conditions as regards loading, although some compression tests are at double the expected load in service.

Various glass articles are being tested for internal stresses, by means of polarized light. The Polaroid Corporation has recently developed a Glass Strain Detector shown in Fig. 11 meeting the specifications of the testing committee of the Glass Container Association. It is built for routine inspection of items in production.

(To be concluded in the January issue)

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Large Attendance at Pittsburgh Meeting on Microchemical Examination

On Monday evening, November 14, a very successful technical meeting was held in the auditorium of Mellon Institute, Pittsburgh, under the auspices of the Society's Pittsburgh District Committee. The meeting had been extensively publicized and a capacity audience of four hundred technical people attended. The general topic was "The Examination of Materials by Microchemical Methods."

The chairman of the District Committee, F. M. Howell, Engineer of Tests, Aluminum Research Laboratories, Aluminum Company of America, opened the meeting with a short welcoming address and introduced H. H. Morgan, Manager, Rail and Fastenings Dept., Robert W. Hunt Co., Vice-President of the Society. Mr. Morgan thanked the committee for their arrangement of the meeting and commended it upon the choice of subject. Mr. Howell then introduced Dr. B. L. Clarke, Chemical Engineer, Bell Telephone Laboratories, Inc., who presided as chairman of the meeting. Doctor Clarke is one of the leaders in microchemical development and is a member of Committee E-3 on Chemical Analysis of Metals, being chairman of its Division D on General Analytical Methods. Doctor Clarke's introductory remarks described the rapid advancement of microchemistry as applied to industrial work in this country in the last five years.

The first paper, "Organic Microanalysis," was given by Dr. W. R. Kirner, Organic Research Chemist, Coal Research Laboratory, Carnegie Institute of Technology, Chairman, Division of Microchemistry, American Chemical Society. Doctor Kirner reviewed the history of microchemistry and outlined its development since 1900. The methods for the quantitative microanalysis of organic and inorganic compounds were described and were illustrated by lantern slides. Economy of time and material were stressed as well as the accuracy and reliability of the methods. Considerable microanalytical equipment was displayed.

Organic microanalysis is used in quantitative microdetermination of elements and groups such as: carbon and hydrogen, nitrogen, sulfur, halogens, oxygen, etc., and this method can also be used for microdetermination of physical constants, such as boiling point, molecular weight, and specific gravity and including the purification of minute amounts of organic material by methods involving crystallization, filtration, distillation, extraction, selective adsorption, etc. Formal discussion of Doctor Kirner's paper was presented by R. O. Clark, Microchemist, Gulf Research and Development Co.

Dr. G. H. Stillson, Organic Chemist, Gulf Research and Development Co., presented the next paper, "Qualitative Analysis by Spot Tests." Spot tests derive their name from the procedure by which an unknown material is allowed to react in a solid, liquid, or dissolved state with a reagent previously absorbed on a piece of absorbent paper. These tests have numerous advantages, the most important of which are their economy of time and material, their reliability, and their high sensitivity.

The Feigl spot test methods for the identification of small amounts of materials were described and some of the tests were shown by means of natural-color Kodachrome slides. Here again the industrial possibilities were emphasized. Many of the tests could be performed in a matter of seconds and showed extreme sensitivities when substances were present which would greatly complicate the ordinary qualitative analysis.

R. B. Unangst, Analytical Chemist, Aluminum Research Laboratories, Aluminum Company of America, and Dr. C. J. Engelder, Professor of Analytical Chemistry, University of Pittsburgh, offered formal discussion on the subject of spot tests. Doctor Engelder told of the influence of microchemistry upon the teaching of qualitative analysis. He is the author of the book "Semi-micro Qualitative Analysis."

The third paper, "Microscopy in Industrial Research and Testing," was given by Dr. E. B. Ashcraft, Microchemist, Chemical and Metallurgical Division, Westinghouse Research Laboratories. Doctor Ashcraft described the modern polarizing microscope and its accessories and showed by charts and lantern slides the many valuable applications of the instrument in identifying materials and measuring their physical properties. Various types of microscopes and their accessories are applied in such fields as qualitative analysis of very small samples, rapid qualitative analysis, phase rule studies, determination of particle size distributions, quantitative analysis, structural studies, etc.

Dr. E. P. Partridge, Director of Research, Hall Laboratories, Inc., presented formal discussion on the subject of microscopy in industry.

The three papers were presented in a style designed to appeal to those not acquainted with microchemistry and many misconceptions regarding the science were corrected.

Arrangements for this very successful meeting were made by Mr. Howell and Eugene Ayres, Gulf Research and Development Co., Pittsburgh, secretary of the District Committee.

Recent Developments in European Research on Fatigue of Metals

By Richard P. Seelig[1]

Editor's Note.—This is the second installment of this paper, the first appeared in the October BULLETIN (pp. 23 to 30 incl.) covering I—Theories on Fatigue and Fatigue Failure; II—Testing Devices; and III—Testing and Evaluation Methods. The complete list of references is repeated in this issue.

CHAPTER IV—Results of Experimental Research

INFLUENCE OF VARIOUS TESTING METHODS AND CONDITIONS

The behavior of materials under combined alternating stresses is a vast field still open for investigation. Gough and Pollard performed experiments in this direction on cast iron, low-carbon steel, and nickel-chromium steel. These materials were tested under varying ratios between flexural stress and shear stress. It is not possible to summarize the results of this investigation without a lengthy discussion of the applied conditions. Those who are interested are referred to the publication in *"Engineering."*

On a new type of impact fatigue tester, exerting fast strokes on a specimen turning 90 deg. between each stroke, Laute found some interesting results which he compared with ordinary fatigue values.

He found that the impact fatigue limit is, as a rule, somewhat higher than that found on a rotating-beam tester. He explains this phenomenon by the fact, that in the case of the quick-impulse tests the resistance of the material against deformation is higher because of the greater speed. This theory checks nicely with the fact that a greater stress frequency on a rotating bending machine also produces higher fatigue values. The impact impulses may be regarded as a very fast stressing action.

Figure 9 shows a comparison between plane bending, rotating bending and impact bending.

Frequent failures of bearings in high-speed engines of various types under severe conditions (as in Diesel-engines) were the immediate cause for special research. Practical experience showed that the orthodox methods of choosing metals, size, and mounting for bearings which had been successfully applied before, did not suffice for these modern-type engines.

The appearance of bearings which had been damaged in practical operation led to the conclusion that repeated impact stresses were the cause for the failure. A testing machine was developed by Thum and Strohauer which exerts this kind of stress on specimens made up from various bearing metals. An essential part of this machine is a connecting rod which is driven by a crankshaft. It performs the beating action on the specimen which, in turn, is held in a spring whose tension can be adjusted. The deformation of the specimen is automatically recorded and the test carried out until the first cracks appear on the surface.

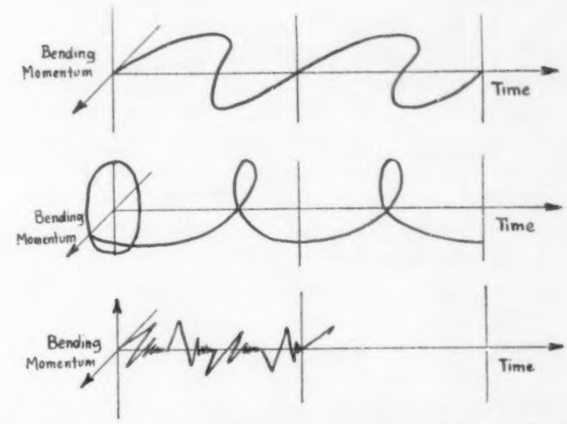

Fig. 9.—Comparison Between Plane, Rotating and Impact Bending.

The results of this machine showed that with decreasing impact load (spring tension) cracks still are formed in spite of smaller general deformation if the number of beats is allowed to be high enough. In fact, it is claimed that a limit of 10 million strokes for the determination of the investigated metals would not be sufficient. Some tests showed small cracks after the specimen had withstood a number of 35 million beats. The impact fatigue limit for these bearing metals is assumed to be at 40 million strokes.

It has been a matter of much discussion whether the frequency of stress reversals has any appreciable influence on the fatigue limit. It seems to be sufficiently clear that it is not necessary to maintain a certain speed in order to make results comparable. On the other hand, it is true that a great difference in test frequency produces deviations in the results.

Koerber and Hempel point out that the distribution of the stresses over the cross-section is a factor to be considered in this connection. To eliminate this influence they used alternating tension and compression tests for their experiments on load frequency. They found that the fatigue limit of steel appears to be about 8 to 13 per cent higher when tested under 450 stress reversals per second as compared with 450 per minute.

INFLUENCE OF VARIOUS MATERIALS

Figure 10 gives the results of tests with complete bearings of various metals. (Thum and Strohauer.)

Mailaender summarizes in a paper the fatigue properties of castings (cast iron, malleable cast iron and cast steel) as found from results of various authors.

He brings an interesting comparison of these cast materials with forged or rolled steel: In contrast to cast materials the rolled steel shows fibrous texture; while in cast materials the strength is uniform in all directions, the properties vary in rolled or forged steel as found by tests with "longitudinal specimens" and "transverse specimens." The bending fatigue strength of steel is lower in transverse specimens than it is in longitudinal bars; the difference increases with rising tensile strength, that is, with rising notch sensitivity. There is no such difference for torsion fatigue results because the main

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication, or for the attention of the author. Address all communications to Society Headquarters.

[1] Plant Manager, Powder Metallurgy, Inc., Long Island City, N. Y. Presented at the Forty-first Annual Meeting, Am. Soc. Testing Mats., Atlantic City, N. J., June 27-July 1, 1938.

[2] A list of references is appended to this paper, see p. 22.

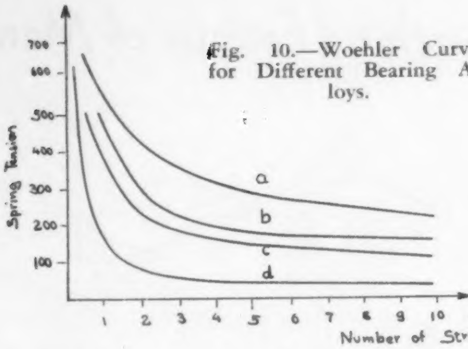


Fig. 10.—Woehler Curves for Different Bearing Alloys.

	Tin, per cent	Lead, per cent	Antimony, per cent	Copper, per cent
Curve a.......	86.5	...	7.5	6.0
Curve b.......	80.0	...	10.0	10.0
Curve c.......	10.0	73.5	15.0	1.5
Curve d.......	50.0	33.0	14.0	3.0

stress acts at an angle of 45 deg. It runs, therefore, at this angle to the directions of the fibers in both longitudinal and transverse specimens. For castings the difference between torsion and bending fatigue limits is rather high. This is explained by the "internal notch-effect."

On account of this same phenomenon the "external notch-effect" is low for cast iron. Therefore, low-grade cast irons have been called fool-proof for this reason. The higher the grade of the cast iron, however, the more it approaches the fatigue characteristic of steel. When using high-grade cast irons, provisions have to be made in designing the shape of the castings, to allow for the shape factor.

INFLUENCE OF SURFACE CONDITION

A series of tests was carried out on a machine exerting an oscillating stress on finished bearings. Similar bearings under equal conditions were compared as to their materials. Woehler curves were taken and the temperatures ascertained. Cracks showed by slight changes in the temperature but were not principally different from those under impact. They originated from spots where notch-effect acted. As a main result of this test series it was found that the temperature has an eminent influence on the performance of the tested metals. While at a temperature of 60 C. the pressure of 97.5 ± 97.5 kg. per sq. mm. was permanently withstood, but cracks appeared at the same stress after 840,000 cycles with a temperature of 92 C.

It was moreover found that enlarged clearance and thicker shell have a detrimental influence.

In his own investigations, the author has studied the influence of small injuries of the surface on the fatigue properties of aluminum wires. The problem arose from the use of stranded aluminum cables as electric overhead power lines. Its practical significance is, however, not limited to the electric field. Its scientific interest is considerable because information in this line may contribute to the general knowledge of the notch-effect.

Generally speaking, it is important to consider the condition of the surface of a fatigue specimen (machined, finished, polished, buffed) because every minute unevenness of the surface can be the cause for a notch-effect. The tests of the author were essentially different from most others in that they were carried out on wires with their natural drawn surface. In other words, injured surfaces were not compared with highly finished ones but with flawless wire surfaces as they occur in cable practice. I want to emphasize this detail because it was not intended to find the fatigue limits of specially prepared specimens with or without notches. Rather, I was called upon to ascertain whether or not there is a difference in endurance between drawn wires with and without injuries. The tests were carried out on a wire fatigue testing machine, system Woernle.

The machine shown in Fig. 11 works according to the testing system under constant deformation. This deformation, and thereby the stress, is given by the radius of curvature of the grooved disk. The wire rotates around its axis, so that the stress cycle is the same as in all rotation bending machines. An additional tensile load may be superimposed. The half-circular disks are interchangeable in order to vary the stress and take Woehler series. The chucks are pivotable in order to adapt their inclination to the various disk sizes.

All injuries to the surface of the specimens were located in such a manner that they extended only over a small part of sector of the circumference. Their sizes were such as not to change the tensile properties of the material; torque tests showed, however, a marked difference. The shapes of the

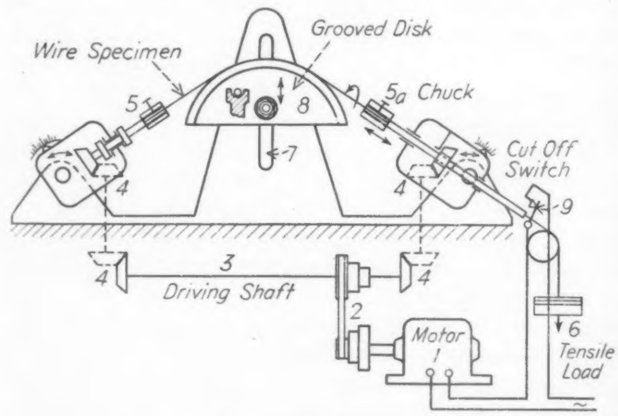


Fig. 11.—Wire Fatigue Testing Machine.

lesions were recorded by means of a "profile projector" in order to detect any deviations of results due to variations in shape in the surface of the notches.

The average values of the notch-effect are shown in Fig. 12. The zero mark indicates the value for the average endurance computed from the results of numerous tests with integral specimens. Three classes of notches, forming two groups of similar depth, are arranged side by side for comparison purposes.

The three kinds of injuries applied were:

1. Notches filed into the surface by means of a triangular needle file.

2. Notches pressed into the surface by means of a triangular scraper.

3. Notches scratched into the surface by means of a razor blade.

It can readily be seen that the first category of notches, as filed into the surface, had only a slight influence on the fatigue properties of aluminum. The last class (scratches) was more severe in its effect. The wedge-shaped injuries pressed into the wire surface show a peculiar behavior: As

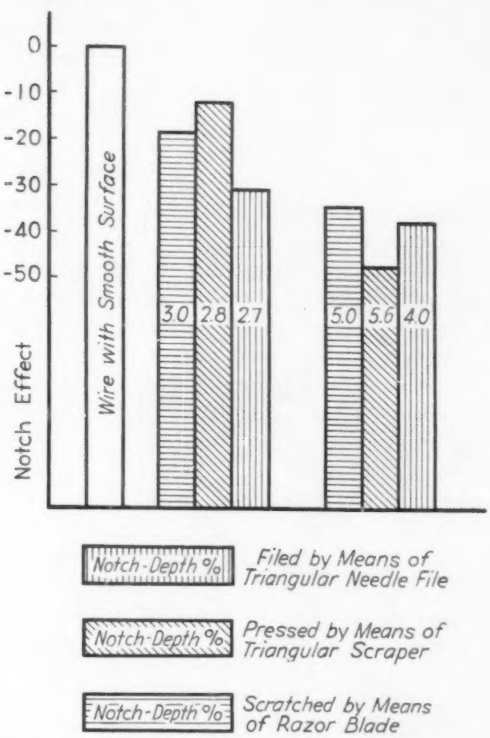


Fig. 12.—Comparison of Various Kinds of Injuries of Equal Range of Depth. Influence on notch effect. Aluminum.

long as they are fairly shallow, their influence is the least of all. But when their depth exceeds 5 per cent of the wire diameter, the endurance is decreased about 50 per cent.

This peculiar phenomenon may be explained as follows: If the tool is pressed into the surface for only a small depth, the material will be pressed aside at this spot thus suffering a strain hardening. This effect will compensate the notch effect to a certain extent. If, however, the depth of the notch exceeds a critical value, the material will separate in the root of the indent, thus forming a sharp minute crack with an extremely high notch effect. An effort was made to find a law of dependence between the variation in test values and the microscopic shape and surface of the scores by means of the pictures taken on the "profile projector." No evidence could be found, however, which would be able to explain the dispersions of results as being due to geometrical differences in the configuration of the notches. With regard to all three classes of notches it became evident that the life of the aluminum wires decreases with increasing depth of the scores under otherwise equal conditions.

INFLUENCE OF CORROSION

It is a well-known fact that the fatigue limit drops considerably if the fatigue specimen is exposed to a corroding medium during the test. Ordinary carbon steels or low-alloy steels with a fatigue strength of 25 kg. per sq. mm. show a fatigue limit of 15 to 16 kg. per sq. mm. under corrosion by water and of 5 to 8 kg. per sq. mm. under corrosion by salt water.

It has been the subject of extensive research work to find means for improving the corrosion-fatigue properties of various metals, especially of steel. Surface coatings, surface pressing, nitriding, case-hardening, and electrolytic zinc protection have been tried for this purpose.

For this kind of test it is of paramount importance to pay attention to the number of stress reversals, on which the fatigue limit is based. Sometimes a coating is able to raise the fatigue of steel considerably for a certain length of time. However, when continuing the test, say up to 100 or 200 million cycles, the effect of the protection vanishes; in this case the protection is unsatisfactory in the long run from the point of view of fatigue.

It is mentioned above, salt water, especially, greatly impairs the fatigue resistance of steels. Juenger reported tests he made along this line. His results are briefly as follows:

Special coatings (parkerising, astramenieren and metallisieren) afforded a moderate increase in corrosion fatigue strength up to approximately 10 kg. per sq. mm. Higher alternating stresses cause minute cracks in the coatings, whereby corrosion-fatigue cracks are initiated rapidly.

Hot galvanizing and lead coating delay the attack by corrosion eminently, but do not cause an increase of the value for fatigue strength.

Surface pressing increases the corrosion fatigue strength considerably on short-time tests. The protecting effect of the primary internal stresses is limited to a certain length of time. When applying a very great number of stress cycles, the fatigue limit of the surface-strained bars is not higher than that of the ordinary ones. Therefore, for practical use this method cannot be considered as improving the corrosion-fatigue properties.

The same holds true for the effect of case hardening; the kinds of steel used (carbon steel and chromium-nickel steel) does not make an appreciable difference.

A definite improvement of the fatigue characteristics could be brought about by nitrided and electroplated specimens only. In these cases the corrosion-fatigue strength rises considerably as compared with ordinary specimens. Practical applications have proved the effectiveness of these methods.

The investigations of Holzhauer dealing with materials used for boilers are generalized for the combined influence of notches and chemical action on the fatigue properties.

This author states that harder materials had higher fatigue limits, even if the formation of the crack was promoted by the corroding effect of the caustic soda.

The smoothness of the surface likewise causes an increase of the fatigue strength. Under this condition, weak solutions of NaOH or Na_3PO_4 furnish smooth coatings which protect against corrosion and, therefore, exert a favorable influence.

Outstanding inhomogeneity in the structure of the materials (layers in the sheets) is of still worse influence under the action of highly corroding alkali.

While uniform strain does not interfere with the fatigue properties of metals in corroding alkali, spots of local cold working appear to be the origins of local attack which on account of their notch-effect form the conditions for the start of fatigue cracks.

Sharp notches decrease the fatigue strength considerably if the primary stresses are low, whereas they act less unfavorably in the range of higher primary stresses, to which the alternating stresses are superimposed.

At elevated temperature (275 C.) concentrated caustic

soda has a very strong corrosion effect, whereas a 0.07 per cent lye shows a distinctive protective influence. Not only does the fatigue resistance rise, but also the formation of cracks at high stresses decreases.

INFLUENCE OF SPECIMEN SHAPE

One of the most outstanding factors influencing the fatigue properties of a material is the notch effect. For static stresses it may be taken into consideration by introduction of a shape coefficient, which in turn may be determined from stress measurements. For alternating stresses, however, this coefficient does not exert its full influence. Another factor, the so-called notch-effect coefficient was therefore introduced. This number is largely dependent upon the material. Experiments intended to determine these two coefficients and their relation to each other are in progress. It is hoped that a "sensitivity coefficient" may be worked out which allows the inclusion of the notch effect into calculations without running special experiments on shaped parts.

The undesirable fatigue strength reducing effect of a notch can be reduced by various means.

The relieving notches, properly applied, have a good effect on pieces under rotating bending stress. The dangerous spots of the construction are placed into the "stress shadow" of additionally applied discharge notches; this results in a decrease of the concentrated stress field at the bottom of the notch.

Artificial internal stresses had an especially good effect on the increase of the endurance quality. This internal strain is used for compensation of the concentrated stress system due to indentations. The proper placement is of primary importance because faulty application of internal stresses may reduce the fatigue limit instead of increasing it.

Oschatz made tests with ring grooves and transverse holes. He increased the fatigue strength of rotating beams up to 34 per cent. He holds, moreover, that even better results can be obtained.

It is recommended that relief notches be used for brittle materials, whereas primary internal stresses are preferable for ductile ones.

The object of experiments by Mailaender and Bauersfeld was to determine the influence of shape and size of the specimens on the results of fatigue tests. They used a special torsion-fatigue machine. The material of the specimens was chromium-nickel-tungsten steel.

It was found that the fatigue limit drops as much as 21 to 29 per cent when changing the specimen's diameter from 14 mm. to 25 mm. Hollow specimens show less decrease than full, smooth rods; and specimens with transverse holes show maximum decrease. For still thicker bars only little more decreasing of the values occurs, so that it is believed that this influence reaches a limit value at a certain thickness. These results check with those of other authors who used rotation bending tests.

The percentage reduction in torsion fatigue strength by change in cross-section (independent of specimen size) was found to be 38 to 47 per cent for transverse holes, 35 to 43 per cent for keyways, and 2 to 15 per cent for hoops and collars.

The opinion is prevailing that there is no law of relation between the fatigue strength of specimens at various sizes and that of specimens of definite dimensions. Kuntze and Lubimoff found, however, that the following law applies: Series of specimens of various shapes, whose materials have the same fatigue limits, retain among each other equal fatigue strength (of different amount) if they are enlarged in equal proportions. It is, therefore, possible to forecast the fatigue strength of a large structural element from the test results of a corresponding smaller specimen, considering also notches, changes in cross-section, etc.

The endurance of a machine part depends not only upon the material and the carrying cross-section, but also on the shape of the member and, so to speak, on its longitudinal section. Some tests with finished parts have been carried out in order to solve special problems of industrial practice. An eccentric oscillator, which could be applied easily to all the various specimens, was used. The tests were evaluated by means of comparison.

Following are some interesting results:

It was to be determined whether or not a slide valve, usually made from tombac, could be made from malleable cast iron instead. This valve was tested for fatigue properties because it was to be subjected to alternating stresses from heat fluctuations and machine vibrations during operation. It was found that the malleable iron outlasted the tombac valve and also two other materials considered.

Another problem was whether or not bolts for connecting rods could be made from nickel steel with 5 per cent nickel as well as from chromium-molybdenum steel. The test was run by stressing two bolts of these materials at the same time. It was found that the chromium-molybdenum steel, which was ordinarily used for the purpose, was superior to the other material.

A very interesting question, indeed, is the following one, also arising in the practice of connecting rod application: If the surface quality of a member under oscillating stresses is of such great importance,[3] will it also be necessary to take special care of the finish of bores in the hollow rods? Subjecting the rods to alternating stresses, it was found that the cracks always started at the outside, even when the outside surface was highly polished and the surface of the bores was rough. The conclusion was drawn, that the finish of the borings is not critical.

In order to prove that the pressure inside a pipe does not have any influence on the results of fatigue tests, two pipes, one with 50 atmospheres inside pressure and the other one with 1 atmosphere inside pressure, were compared. As expected, the inside pressure did not have an appreciable influence on the fatigue properties of the pipes.

It was observed that coiled pipes crack occasionally in the neutral fiber of the curve. This was attributed to fatigue phenomena on account of pressure fluctuations or mechanical vibrations. By means of shape-fatigue tests this assumption was proved. Moreover, the reason for the failures and means for their prevention were found: By coiling a pipe, its cross-section becomes elliptical. Under the action of inside pressure, the pipe has the tendency to resume its circular shape, thereby stressing the apparently neutral fiber in tension. The failures could be avoided by giving the coiled pipes a circular cross-section.

An outstanding practical example of parts where the influence of sharp grooves is important, are screws. The fatigue

[3] See p. 16.

strength of screws rises with increasing length of the thread. The decrease of the shaft diameter below the root diameter of the thread improves the alternating impact strength. Only a small increase of the rounding in the thread base raises the alternating impact energy to almost three times the value of ordinary threads. The rounding at the heads of the screws should also have a somewhat greater radius than ordinarily.

Fatigue failures occur frequently at those portions of machine parts where stresses are transmitted, where grippings are applied, or where naves are fitted. Realizing that these danger points represent a special field of interest in the fatigue research, Thum and Wunderlich made some experiments with structural elements of this kind, stressed by alternating deflection.

The following results were found:

The fatigue strength decreases with increasing chucking pressure at the beginning rather rapidly, later slowing down and approaching a constant value. This law applies as well to hard as to soft gripping materials; its course depends upon the two metals concerned.

The more sensitive a material is to the influence of notches, the more considerable is also the decrease of the fatigue limit by effect of chucking. The grip-fatigue strength, as the authors call it, amounted to 60 per cent of the regular fatigue limit for moderately notch-sensitive materials, and down to 30 per cent of the fatigue limit for such materials which show a strong influence also of notches on their fatigue properties.

Several means to counteract the detrimental influence of gripping are also mentioned by the authors and were tested for their effect. Proper design of the shape and proper selection of the material for the chucks can increase the fatigue limit of the construction materially. Submitting the gripped part to primary compression stresses resulting in plastic deformation at the critical portion, case-hardening or nitriding decrease the influence of chucking. The degree of this improvement depends upon the material and the method applied.

Neither oil nor water were found to have any material influence on the described phenomenon, disregarding, of course, the corrosion-fatigue effect.

Rods tested with their rolled unmachined surfaces largely showed varying endurance values. Accidental conditions of the surface play a primary part. But generally speaking, the decrease of the fatigue strength is somewhat smaller than for machined and polished surfaces.

Unevenness of the gripping surface has a highly disadvantageous influence. This shows up only after a considerable run; for this reason short-time tests may produce erroneous results.

The stiffer the grip—provided the specific surface pressure is kept constant—the lower is the fatigue limit.

Internal primary tension stresses decrease the fatigue strength. Comparative tests proved that hoops with sharp shoulders are worse than chuckings; however, rounding off the transition to the hoops increases the fatigue limit considerably.

One-side repeated impact-bending tests showed convincingly that pressure bending stresses play an important part and are more dangerous than tension-bending stresses.

The dangerous influence of gripping is not caused by the formation of a stress concentration, as is the case with sharp steps, but, rather in a special way, by the changes in deformation. This was found out by means of optical polarization tests.

It is a known fact that the shape of specimens influences the results of long-time tests. A testing machine has been built for bearings ready for use. The machine constitutes an imitation of a connecting rod which is moved by a crankshaft and hits with each revolution a plate held and loaded by a powerful spring. This way the bearing which is attached to this connecting rod is submitted to fatigue impact stresses.

The results on this machine showed that failure of bearings is not so much to be blamed on the poor fatigue qualities of the metals used as on the way of mounting the bearings, which was found to be extremely critical. Only slight variations in the fit of the bearing in the connecting rod—either too tight or too loose a mount—caused cracks transverse to the surface movement similar to those found in actual failures.

Grooves and holes in the stressed part of the carrying bearing surface, often used for the feeding of lubricants or for the fastening of safety pins against torsion, are to be avoided.

It is to be noted that the bearings were tested under actual conditions, that is, with lubrication and after a break-in period and at a normal working temperature.

INFLUENCE OF METHOD OF MANUFACTURE

Very striking is the influence of the method of thread manufacture. Rolling of the thread after normalizing causes an alternating impulse work 6 times as high as that for machined threads.

Aging, bringing about an appreciable increase of the tensile strength and the yield point, raises the fatigue limit only very slightly. Coarse-grain recrystallization tends to decrease the fatigue limit markedly. Precipitation hardening and case hardening cause a considerable increase of the endurance also under simultaneous corrosion. Quenching improves this tendency still further.

VARIOUS JOINTS (SCREW CONNECTIONS, RIVETED CONNECTIONS, WELDED CONNECTIONS)

Screw Connections; Riveted Connections:

A number of extremely interesting investigations with screw connections submitted to repeated impact stresses and under various tensions have been carried out in Darmstadt, Germany. Due to limitation of space, not more than a brief abstract can be given. Anyone who faces the problem of dynamically stressed screw connections and who is interested in knowing how to improve their resistance against fatigue, should read the research report of Thum and Debus. New ways are shown of calculating these connections so that they will not fail on account of fatigue. Diagrams were plotted for the repeated impact strength for screws having an additional stress in tension or in tension and torsion (by the tightening action). The value of these primary stresses is of paramount importance. Helpful suggestions are made as to calculation, design and maintenance of fatigue-proof screw connections.

Fatigue cracks in riveted bars originate from such zones on the inside or outside of the riveted straps, which are attached by friction-oxidation, thereby the fatigue limit becomes appreciably lower. In other words, the cracks do not

necessarily start from the edges of rivet holes but from such spots which are determined by some abrasive action.

Welding Connections:

Welding Method.—Arc welding and gas welding are generally to be considered equivalent for dynamically stressed structures.

Welded Material.—The endurance properties of different steels with different yield points vary only slightly. This also has been found true for welded materials.

Welding Rods.—Fatigue tests have proved that joints made with welding material of moderate strength but considerable elongation and with outstanding yield point, furnished higher fatigue strengths than such joints as made up with welding material of high strength but lower elongation.

For dynamically stressed welded joints, the following requirements have to be fulfilled:

1. The surface of the bead must be smooth, especially the transition of the sheet to the bead must be gradual, without holes or notches.
2. The weld has to be free of slags and pores inside; it should have good penertation all around.
3. When using arc welding, the arc should be kept as uniform as possible; no breaking should occur.
4. The dimensions of the beads should be kept closely to the prescribed measurements.
5. The fatigue strength of the welded joint should be as high as possible.
6. The weld must be highly ductile.

DESIGN AND FORM OF WELDED JOINTS

1. *Butt Seam Welds.*—There has been and still is a wide skepticism against butt seam welds, which is purely arbitrary. Since investigations have been made with fatigue tests, the general opinion changed entirely. Butt seam welds stand up better against fatigue than fillets because of the natural straight flux of force. It may be emphasized again that the quality of the welding performance plays a paramount part and that a poor job gives only 50 per cent of the fatigue strength of a good welded joint, even if there is little or no difference in tensile strength.

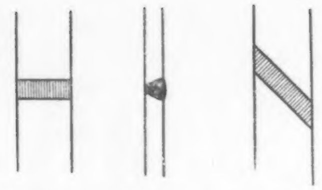
The bead has to have a moderate slope and should protrude only a little over the surface of the parts to be welded. It is erroneous to believe that a thicker bead produces a higher fatigue resistance; the contrary is the case.

For butt seam welds it is extremely important to reweld the root of the welds after removing the slag.

By planing and finishing the beads of butt welds on both sides parallel to the direction of the tensile stress, the fatigue strength can be increased considerably. This is due, again, to the creation of a smooth, flawless surface, which is more important than a heavier cross-section. Grinding the beads, so as to create smooth transitions, has the same effect.

It is absolutely useless to apply welding rod material of higher strength than the welded material. In most cases the joint does not break in the weld but in the transition zone where the crack is started by notch effect.

The endurance of butt seam welds may be increased approximately 20 per cent by running the seam at an angle of 45 deg. to the edge of the sheets:



Fatigue Strength 18 kg. per sq. mm. Fatigue Strength 22 kg. per sq. mm.

The explanation for this phenomenon is simple: The fractures are indicated by notch effects in the welds. When the seam runs at an angle of 45 deg. to the stress direction, most of the material in the cross-section normal to the stress consists of matrix, henceforth the notch effect is less dangerous.

As compared with unwelded flat bars, butt seam welded joints reach the fatigue strength of bars with bores. The endurance of plain unwelded sheets cannot be attained by butt seam welds.

2. *Fillets in Parallel Shear.*—The flux of force for fillets running alongside the flanks of the straps is essentially unfavorable as compared with butt seam welds. The lines of force are crowded at the transition to the straps, and enter into the lateral beads. The forces change directions, and transverse bending of the connected bars is the result. Even specimens shaped in the same manner but machined from solid pieces show a distinct decrease in fatigue strength. In addition to this we still have the notch effect of the bead itself and its transition to the matrix.

For all these reasons the difference between static and dynamic strength of fillets in parallel shear is larger than that of butt seam welds. As a matter of fact, the tensile strength of both is almost the same.

For constructions which are to be stressed dynamically (bridges), fillets should not be used unless the allowable stresses are reduced materially not only for the joint but for the beams themselves.

High stress peaks occur at the ends of flank fillets; they can be dissipated by local giving of the material. This calls for the use of highly ductile welds (deformation 15 per cent or more).

Deep penetration of the weld into the sheets changes the microscopical structure of the steel and causes notch-effects. It should be kept moderate, and the dimension of the filled beads should be maintained closely.

The bond of the weld in the root is of utmost importance. It is, therefore, highly advisable to preweld the fillets with a thin wire, if for the full weld thick welding rods are to be used. It is a matter of great skill on the part of the welder to produce the bond at the bottom of the fillet without causing undesirable penetration at the rest of the seam.

In certain cases it may be well to use several small straps instead of one very wide one.

The weld should never run beyond the joint; also the bar ends should not be too close together. A good clearance allows the flux lines of force to take a smooth stretched shape.

Continuous fillets are better for dynamically stressed parts than interrupted ones.

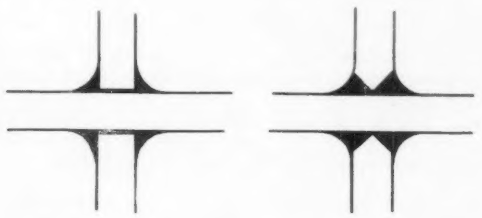
General points concerning transitions, penetration, etc., are the same as for butt seam welds.

3. *Fillets in Normal Shear.*—Here the same principles apply as for 2. Fillets normal to the fatigue stress direction should be avoided.

The shape of the seam plays an important part and the investigations on fatigue properties actually reversed the conception generally accepted before.

For, it became evident that for all fillets in normal shear, which are to be stressed dynamically, not the full shape, but the hollow shape with an average angle of about 45 deg. is most satisfactory. It seems as though certain coating or fillings for welding rods cause the fillet to take a more favorable geometrical shape.

It was found that by bevelling the ends of the strips, the fatigue strength of a cross-shaped connection could be increased materially.



4. *Butt Seam Welds and Fillets.*—Finally it was determined whether a butt seam weld can be improved in its strength by addition of a strap which, in turn, is fixed by fillets. The tensile strength could indeed be increased this way, to an extent which almost corresponds to the increase of the cross-sectional area. This, however, is not the case for fatigue stressed joints. The fillets result in disturbances of the flux of force. Bad butt seam welds may be improved somewhat by stiffening with straps. On the other hand, good butt seam welds may even be impaired if the fillets are not properly done.

RELATION TO OTHER MATERIAL PROPERTIES

Extensive research has again, as in former years, been carried out on the problem of the relations between the fatigue limit and other material properties. An interesting chart, as compiled by Cazaud, may be given here:

Author and Laboratory	Number of Steels Tested	Ratio, fatigue limit to ultimate strength		
		minimum	maximum	average
Moore, University of Illinois	28	0.35	0.61	0.49
McAdam, U. S. Naval Research Laboratory	23	0.35	0.61	0.44
Gough, National Physical Laboratory	55	0.35	0.61	0.46
Ludwik (Vienna)	27	0.35	0.65	0.50
Cazaud, Service des Recherches de l'Aeronautique	95	0.19	0.66	0.435

A definite relation between the elastic or the proportional limit and the fatigue limit holding for several metals has not been found. Contrary to a widespread opinion the fatigue limit is found above the proportional limit for steels as well as for non-ferrous metals.

The ratio to the yield point varies widely: It was found to be 1:3 for an age-hardened aluminum alloy, 1:2 for chromium-nickel steel and 2:1 for electrolytic copper.

A definite relation between fatigue strength and tensile strength, which holds true for all kinds of metals of experimental investigations resulted in some formulas which hold true in a reasonable range of deviation.

CONCLUSION

In conclusion, a summary of the trends and an outlook into the future of modern fatigue research in Europe may be in place. As we saw, many developments abroad are along the same lines as here, the requirements of engineering being the same everywhere. On the other hand, we also found that there are a number of phenomena and details which find undoubtedly more attention in European laboratories than they do in this country.

In this connection an outlook into the future of fatigue research seems very interesting.

The study of the notch effect on fatigue properties is taking a great deal of attention and will probably continue to do so. Several authors are now working on the explanation of these effects. They are trying to find the reason why many metals are very sensitive for irregularities in the surface, whereas others are not. The rôle that an artificial decreasing of stress peaks and the state of polyaxial strains play is being investigated. The distribution of the stresses along the specimens with and without notches, or otherwise changed against the normal state, is subject to careful studies.

It is rather interesting that the effort spent on research with so-called short-time tests has decreased appreciably during the last two years. It seems as though, at last, the perception has won ground that there is no such thing as a short-time test which would be able to replace principally the fatigue tests whose very nature involves the application for a considerable length of time—or better, a considerable number of stress cycles.

There is undoubtedly a tendency toward standardization. So far, to the author's knowledge, only in Germany are there standard specifications in existence. They apply to definitions, terms and symbols only, whereas there has been nothing done about specimens and testing procedure. The development also does not seem to have reached the stage where standardization for inspection purposes would be advisable or possible.

The survey on European fatigue research made it evident that there is a decided tendency toward testing full-size and shaped structural parts. Moreover, the influence of specimen size and shape are being investigated by various authors. This will certainly continue taking their interest in the future.

The final aim of fatigue research is, of course, the explanation of the fundamental phenomena and their connection, so that it will be possible to determine the fatigue resistance of pieces of arbitrary material, shape, and size, with sufficient accuracy from the results of simple tests with standard specimens. It need not be stressed, however, that this end may not be attained in the immediate future.

Research men all over the world are working in this direction and its achievement will create a new basis for the calculation of structures in all fields of engineering where dynamic stresses occur. It will make possible a safer and more economical use of engineering materials and thereby be an important factor in technical progress.

It cannot be forecast when this stage will be reached, but it is certain that a joint effort of all interested scientists will promote this development. For this very reason the author believes that it is important to keep abreast of the development abroad. If this paper is a contribution to this end, it will have served its purpose.

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DISCUSSION

MR. H. F. MOORE[1] *(by letter).*—It is thought that Mr. Seelig's valuable paper may be supplemented by reference to work which has been done or is going on in laboratories in this country, and which parallels or supplements the European work described by Mr. Seelig. This discussion falls far short of being anything like a complete list of American fatigue studies, but it is hoped that it may be of service, especially to those who do not have access to the references given in Mr. Seelig's paper.

In the fourth paragraph of the introduction to Mr. Seelig's paper[2] the number of cycles of stress regarded in European laboratories as adequate for determining endurance limit is stated to be 1 to 2 millions for steel, and while no definite number is specified for non-ferrous metals, 200 million is mentioned as the figure sometimes used for aluminum alloys. In this country 10 million is a figure frequently used for steel **(17, 13)**,[3] while 500 million has been used for aluminum alloys by some experimenters **(17, 7, 21)**.

In the fifth paragraph it is stated that the assumption of a definite fatigue limit is generally accepted in Europe. This is hardly the case in America for certain non-ferrous metals **(7, 13)**, although it has been suggested that air-corrosion-fatigue **(18)** may be an explanation of the apparent absence of a definite endurance limit for those metals.

In the sixth paragraph surface conditions and microscopic structure are given as the most important factors affecting the fatigue properties of a piece made out of a given metal. American opinion is, I believe, that surface condition is the most important factor, if scratches, notches, cracks, holes and other "stress raisers" are listed among the surface conditions. However, by many, apparently including Mr. Seelig, "stress raisers" are listed as form factors, not as surface finish.

In connection with Chapter I, section on Fatigue and Crystalline Structure,[2] it may be noted that the relationship between "sliding" resistance and "tearing" resistance of a metal has been discussed in American publications by Hoyt **(6)** and McAdam **(9)** among others.

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[1] Professor of Engineering Materials, University of Illinois, Urbana, Ill.

[2] ASTM BULLETIN No. 94, October, 1938, p. 23.

[3] The boldface numbers in parentheses refer to the reports and papers appearing in the list of references appended to this discussion.

In the last paragraph of this section the statement is made that in the case of a brittle metal no plastic deformation occurs. In this country many metals regarded as brittle show definite evidence of slip before fracture occurs. It may be doubted whether any metal ever fails without some plastic deformation unless it is subjected to "three-dimensional" tensile stress.

In connection with Chapter I, section on Damping Capacity,[2] reference may be made to the paper presented by Brophy (2) before the American Society for Metals, together with the discussion following.

In connection with Chapter I, section on Fatigue Failure,[2] although it is a reference to European work, attention may be called to the extensive work which Bacon (8) has done at the University of Cardiff, Wales.[2]

In Chapter II, section on Rotating Bending,[2] it is stated that 10 to 20 specimens are necessary to determine endurance limit. In American laboratories six are usually found sufficient, although it is always advisable to have enough material on hand to make 12 specimens (17, 19). Details of fatigue specimens used in American laboratories are given in references (19, 17, 14 and 21).

In the closing paragraph of this section, reference is made to fatigue tests of full-size structural and machine parts. In this country full-size fatigue tests made or in progress include tests of riveted structural members (23), welded structural members (22), locomotive and car axles (3), wire ropes (4), railroad rails (16), and pressure vessels (10).

In connection with sections on Torsional Fatigue Testing Machines and Alternating Tension and Compression of Chapter II,[2] the following references give descriptions of fatigue testing machines in use in this country (3, 4, 10, 13, 14, 16, 17, 19, 21, 22, 23).

In the section on Alternating Tension and Compression,[2] Chapter II, the statement is made that the fatigue limit obtained by tests under reversed axial stress (tension-compression) is lower than that obtained by a reversed-flexure (rotating-beam) tests. Experience in this country indicates that much, if not all, the difference is due to the failure to obtain perfectly uniform stress distribution in fatigue specimens under direct axial stress.

In connection with Chapter IV[4] it may be noted that American results on effect of speed of testing are given in references (17, 14), some American results on effect of surface condition are given in references (5, 13, 23). In this same section the wire testing machine shown in Fig. 11 is quite similar to that used by de Forest (4). In connection with the effect of notches in reducing fatigue strength the work of Peterson and Wahl (15) has been noteworthy in this country.

In connection with Chapter IV, section on Influence of Method of Manufacture,[4] some results from an American laboratory are given in reference (11). In this country it is doubtful whether grain size is regarded as important a factor in fatigue strength as is indicated in this paragraph of Mr. Seelig's paper. In connection with Chapter IV, section on joints, American test results on the strength of screw threads, riveted connections, and welded joints may be found in references (12, 23, 22, 10).

In Mr. Seelig's conclusions it is stated that the only standardized specifications for fatigue testing are the German specifications. In this country the A.S.T.M. Research Committee on Fatigue of Metals has given its opinion that the time is not yet ripe for standardization of test methods.

[4] See p. 15.

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XXI. Long-Time Society Committee Members

Twenty-first in the Series of Notes on Long-Time Members

As a continuation of the series of articles in the ASTM BULLETIN comprising notes on the outstanding activities of long-time A.S.T.M. members, there are presented below outlines of the work of three additional members. In general the men whose activities are described in this series have been affiliated with the Society for 25 years or more and have taken part in committee work for long periods of time. No definite sequence is being followed in these articles.

W. A. COWAN, for many years Assistant Chief Chemist, National Lead Co., Brooklyn, N. Y., was graduated from Amherst College in 1897 with the degree of B.A. For two years he was Laboratory Assistant and Instructor at the Brooklyn Polytechnic Institute and in 1899 entered the employ of the National Lead Co. Beginning in 1905 he has been connected with the Research Laboratories and was Assistant Chief Chemist from 1914 to his retirement on July 1 of this year because of poor health.

H. L. Sherman W. A. Cowan **F. A. Barbour**

Mr. Cowan has been especially interested in the metallurgy and metallography of lead alloys and white metals and other non-ferrous metals and alloys and became an authority in this field.

His membership in the Society dates from 1913, at which time he also became a member of Committee B-2 on Non-Ferrous Metals and Alloys. For many years he was chairman of its Subcommittee on Methods of Chemical Analysis. He has been a member of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys since its organization in 1922 and of B-6 on Die-Cast Metals and Alloys since it was established in 1930. Other committee affiliations include B-5 on Copper and Copper Alloys, B-4 on Electrical-Heating, Electrical-Resistance and Electric-Furnace Alloys (since 1922) and on Committee E-8 on Nomenclature and Definitions as the representative of Committee B-3.

He has been the author of numerous papers and reports in the field of non-ferrous metals. Beside his long-time Society membership, he has been affiliated with the American Institute of Mining and Metallurgical Engineers, British Institute of Metals, Franklin Institute, American Association for the Advancement of Science, Society of Automotive Engineers, Mining & Metallurgical Society of America, and the American Society for Metals.

F. A. BARBOUR, Consulting Hydraulic and Sanitary Engineer, Boston, Mass., after he was graduated from the University of New Brunswick, spent some ten years in railroad work and on municipal projects, chiefly water supply and sewerage disposal work, before engaging in private practice. During this period he conducted one of the early investigations of the strength of sewer pipe and loads developed in trenches with various depths of materials. He has supervised the design and construction of a large number of water supply and sewerage systems, including purification works, sewerage disposal plants and the like. A number of his activities have involved appraising of various water companies and water supply systems; testimony in interstate cases and similar projects.

Mr. Barbour has been a member of the A.S.T.M. since 1898 and at the 1938 annual meeting was one of the eight individuals awarded the Forty-Year Membership Certificate.

He has been particularly interested in the testing of cast iron and vitrified clay pipe.

He has taken part in several committee activities, in particular, C-4 on Clay Pipe on which he has held membership since 1910. His activities also include Committees A-3 on Cast Iron and C-13 on Concrete Pipe and he is a member of the Sectional Committee on Specifications for Cast Iron Pipe. From 1933 to 1935 he served as a member of the Society's Executive Committee.

He is a member of a number of professional and technical societies including the American Society of Mechanical Engineers, American Public Health Association, American Society of Municipal Engineers, is past Director of the American Society of Civil Engineers, and past president of three groups: the New England Water Works Association, Boston Society of Civil Engineers and American Water Works Association.

HERBERT L. SHERMAN, Treasurer, Skinner & Sherman, Inc., Boston, Mass., graduated from Massachusetts Institute of Technology in 1902 with the degree of B.S. in Chemistry. After a short period as a water analyst and assistant in mineralogy at M.I.T., he was engaged by F. W. Kelley, then General Manager of the Helderberg Cement Co., to join his organization at Howes Cave, N. Y. Following this initial experience in the chemistry and manufacture of portland cement, Mr. Sherman was placed in charge of the testing of cement and concrete materials for the United Shoe Machinery Co. at Beverly, Mass., then building one of the early, large, reinforced concrete group of buildings of New England.

Later, he established his own laboratory in Boston and conducted a general analytical and testing business. In successive steps, this business became Sherman & Edwards and, later, the New England Bureau of Tests. During the World War, he was Assistant Head and, later, Chief of the Inspection Department of the Construction Division of the Army. At the close of the War, he went with Arthur D. Little, Inc., in charge of their Commercial Dept. In 1921, Mr. Hervey J. Skinner and Mr. Sherman formed Skinner & Sherman, Inc., which organization has since conducted a chemical consulting, research, and testing business in Boston.

Mr. Sherman became a member of A.S.T.M. in 1904 and has taken active part in the work of Committee C-1 on Cement for many years, having served on various sections and subcommittees.

He is a member of the American Chemical Society and the American Concrete Institute, and is the representative of the American Chemical Society on the Highway Research Board.

Some Pros and Cons of Radiography[1]

By G. C. McCormick[2]

A Discussion of Some of the Relationships Between the Service of High Nickel Alloy Castings and Their Soundness as Disclosed by Radiographic Examination, with Notes on the Use of Radiography as a Development Tool in Foundry Technique.

No one can read Lester's excellent paper on "Radiography in Industry"[1] without being impressed with the many evidences of progress and the great divergence in the attitudes of industrial representatives toward the radiographic method. We find on one hand confidence and understanding, and on the other distrust, misunderstanding and occasional misuse. I refer particularly to the exploitation of radiography in a manner similar to the early exploitation of the electric melting furnace.

Early users of electric melting furnaces claimed peculiarly advantageous properties for the steels melted therein, and many unwarranted claims were made for products so melted. There has appeared a certain exploitation of the X-ray in a similar manner.

There is no quarrel with thorough X-ray inspection of products involving life, limb, or the maintenance of vital public services. In the writer's opinion, however, and for reasons hereinafter set forth, the presumption of complete X-ray inspection of products, particularly castings, not involving life or vital services, can be definitely misleading and may react to the discredit of the X-ray as a development and inspection tool.

A high percentage of the gross tonnage of castings produced by industry is for industrial consumption not involving vital consequences, and the exploitation of the X-ray in the presumption of complete inspection of such products may result in a loss of consumer confidence in the X-ray method or a serious and logical questioning of the capacity or competence of foundries who feel that their entire production of a certain class of castings needs X-ray inspection in order to establish consumer confidence therein. Lester proposes the establishment of a group or classification of vital or highly stressed castings for which X-ray inspection would be mandatory. In this we highly concur, and in concurring desire to emphasize that there is a large percentage of castings for industrial application on which the imposition of X-ray inspection is unnecessary and unjustified.

As will be subsequently shown, castings showing defects in X-ray examination may perform well, and other castings free from defects as detectable by the X-ray may not have the degree of soundness which the consumer expects.

Lester has well set forth that the X-ray is an excellent development and inspection tool. In the foundry industry its greatest utility will come in its employment as a development tool and as a check inspection device on castings involving life and vital public service, and as an occasional inspection device on severely stressed parts of mechanisms.

As far back as 1923 or 1924 when the X-ray was first brought into prominence at the Watertown Arsenal, the writer, through his connection with a large textile machinery plant, used the X-ray to persuade a hard-boiled, old-school foundry superintendent that castings could contain defects resulting from improper gate and riser application and poorly conditioned sand, and not as the foundryman would have it, entirely the fault of the metal and some mysterious harmful ingredient therein.

We are constantly studying a variety of castings with the X-ray in order to improve their soundness and establish the relation to service life under conditions of high temperature in a variety of atmospheres and in problems of corrosion involving pressure or non-pressure work.

We have investigated the relationship between defects, as indicated by the X-ray, and subsequent failure. While we have found cases in which the eventual failure is intimately related to or identified with X-ray defective area, we also find that in several investigated cases parts may show defects, but fail in areas that are apparently sound. I am referring to high alloys of nickel, chromium and iron in a variety of compositions, and for high-temperature service, and it would be interesting to know what comparative experience has been developed in other industries, if any.

Figure 1 shows a typical pot used for cyanide, lead, or salt hardening. Hundreds of pots of this type are in service. The pot is made of approximately 60 to 65 per cent nickel and about 15 per cent chromium. Service hours from this pattern were improved by X-ray studies by about 240 per cent. The pot shown is typical of many that are fired by fuel or heated electrically, and it is a characteristic habit of operation in most plants using this equipment that rarely is the recommended and desired care given to their pots, which if given is known to improve service.

Figure 2 shows a complete X-ray examination of one pot which lasted approximately 4000 hr., and which shows numeroust defects, none of which was associated with the eventual

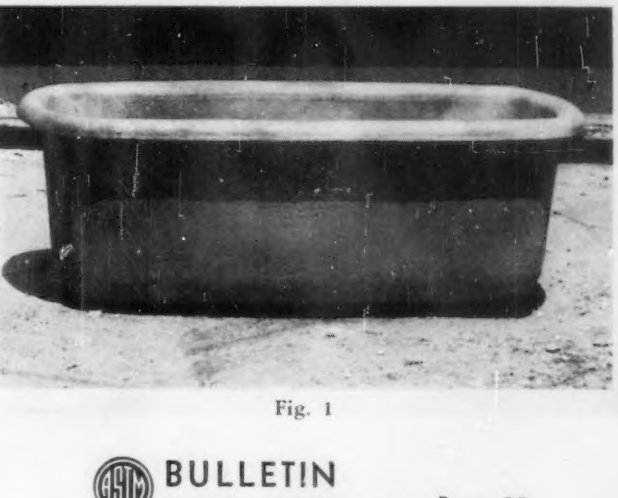


Fig. 1

[1] Presented at the Forty-first Annual Meeting, Am. Soc. Testing Mats., Atlantic City, N. J., June 27—July 1, 1938, as a discussion of the paper by H. H. Lester on "Radiography in Industry," ASTM BULLETIN, October, 1938, No. 94.

[2] Vice-President, General Alloys Co., Boston, Mass.

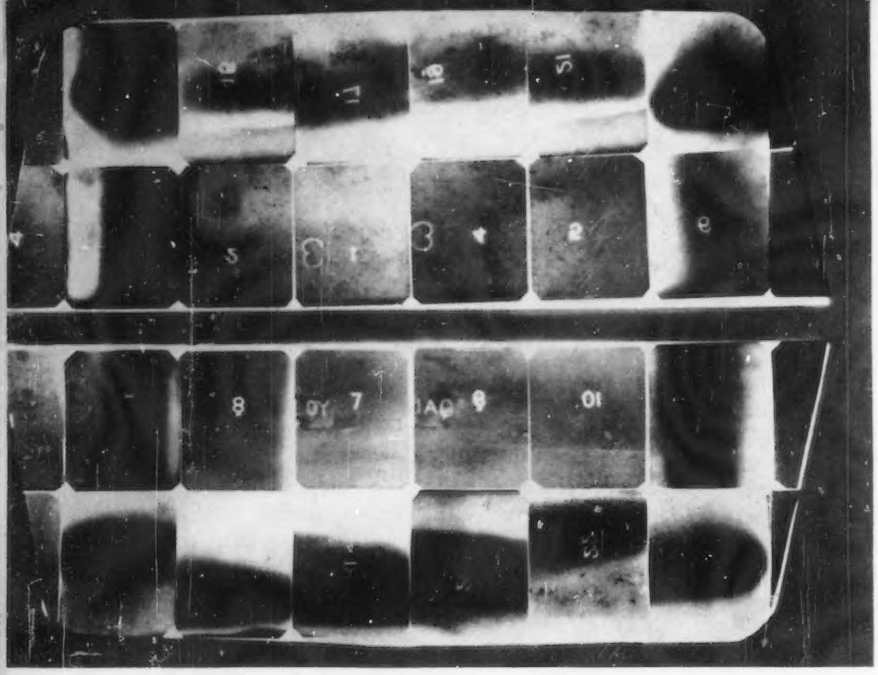
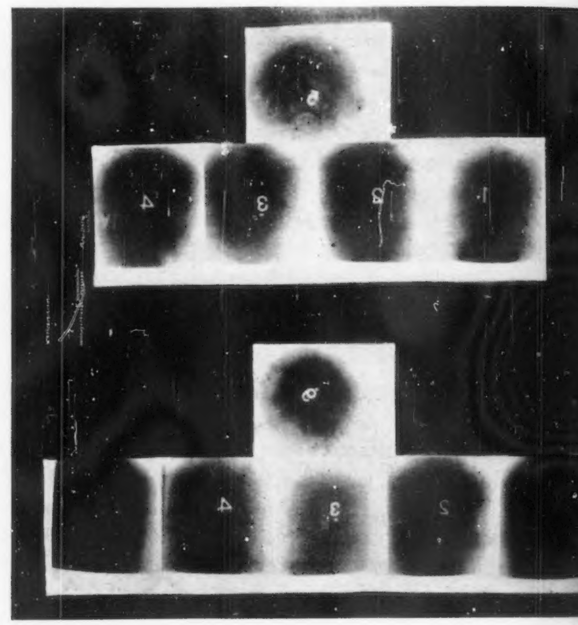


Fig. 2

Fig. 3

Fig. 4



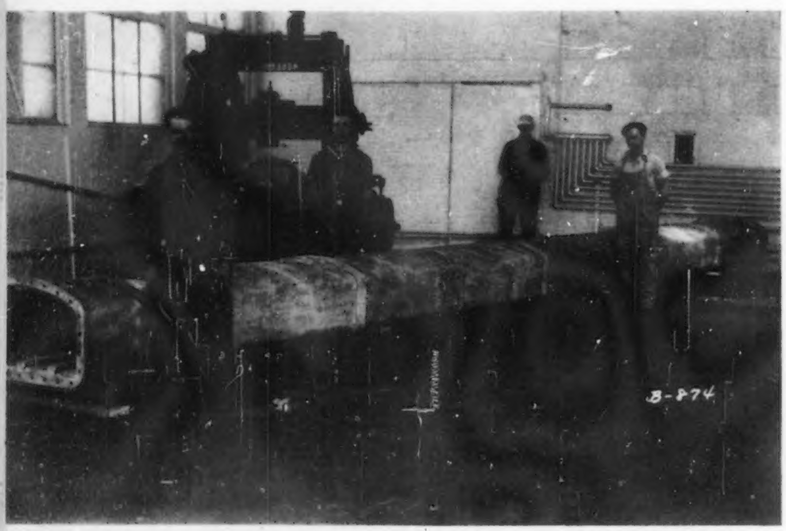
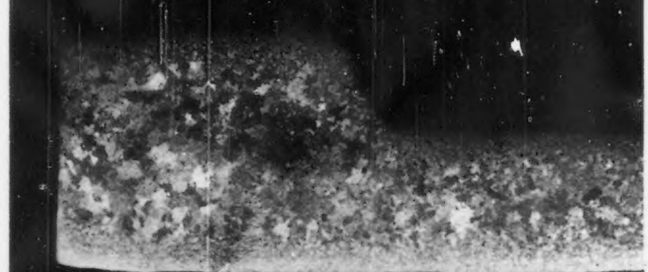


Fig. 5

Fig. 6

Fig. 7



failure. The failure occurred at the liquid-level line, due to corrosive action of the salt held therein on the metal of the pot. This is a case where there is direct evidence of unsoundness as disclosed by the X-ray and which is not associated with the actual failure.

Figure 3 is an additional study of a smaller round pot, of which many are in service, and which is typical of container construction and has widespread use.

Figure 4 shows X-ray photographs of these pots, showing failures not related to the defects indicated in the X-ray. This also shows relationship between the effectiveness of risers and the particular manner in which these pots were made, indicating that in these metals the riser effectiveness is limited to an area immediately below the riser. There is no evidence, either from visual examination of riser after casting or through X-ray study of deep feeding.

Figure 5 illustrates a muffle assembly used for gas carburizing, each section of the muffle being approximately 30 by 14 in. in cross-section, 4 ft. long, and weighing around 550 lb. with a $1/2$-in. wall. In gas carburizing the precipitation of amorphous carbon, resulting from the cracking of the gas, obviously takes place wherever the gas may be, and it is a most desirable requirement that these castings be free from all defects of a surface or deep-seated character, into which the gas may find access. Because, through repeated cycles of operation, amorphous carbon, precipitated between the inter faces of any defect, accumulates, increases in volume, and results in an eventual rupture of the casting wall. This condition is sometimes referred to as "carbon explosion." The specification under which this muffle is produced requires that the muffle shall be gas tight at 5 lb. of air pressure. The fact is that this test is misleading. All muffle sections shown in Fig. 5 successfully met this specification, but in the production thereof certain castings showed leaks under this pressure, which could not be traced to defects detectable or observable by the X-ray or other methods.

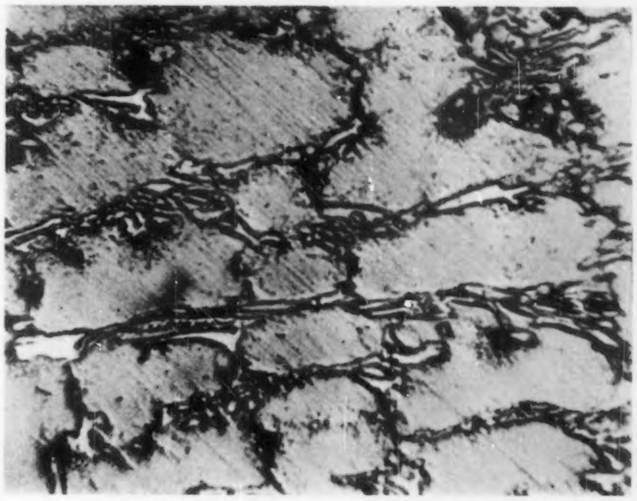


Fig. 9

Figure 6 shows a test being conducted on a small section of a scrapped casting taken from one of the areas alongside the rail. This test was made by tapping a $1/4$-in. pipe into the casting and applying 50 lb. of air pressure directly into the casting wall. The soap bubbles indicate that the leaky or porous condition extended over a considerable area, along the juncture between the bottom of the muffle and the rail side. These bubbles extended as far as 2 in. from the end of the tapped hole.

Figure 7 is an enlargement of another section of this muffle, showing the existence of a slightly porous area at the junction of the thick and thin sections. No leak was detected through this area.

Figure 8 illustrates the sharp grain size differential in adjacent thick and thin sections, and also illustrates radial orientation of grains from the chills set in the juncture.

Figure 9 illustrates one of several photomicrograph specimens taken from leaky sections of the muffle. Specimens were sectioned at different angles, deeply etched, dried, and left until seepage began. Photomicrographs were taken of stained areas. No fissures or cracks were detectable in the areas discolored by acid seepage. The dark areas, which might be interpreted as holes or sections of fissures, were examined

Fig. 8

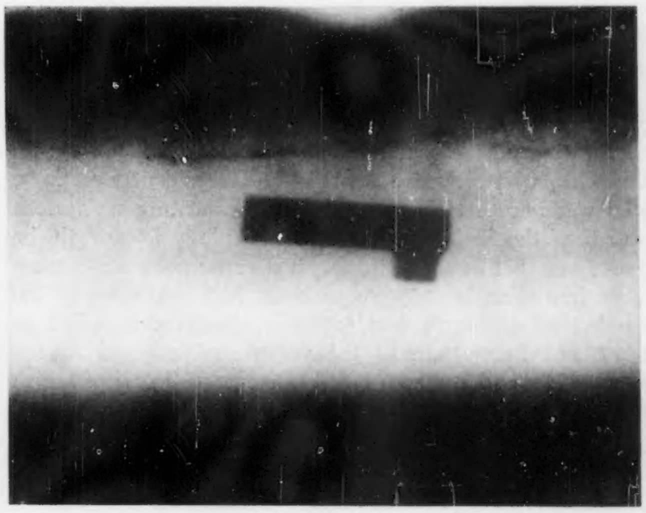


Fig. 10

Fig. 11

under polarized light and indicated definitely on rotation that these areas are not voids.

Figure 10 is an X-ray photograph of a portion of a definitely leaky section of the muffle. This and other similar photographs show a variety of porous spots and cavities, but in no place is there evidence of a *continuous* fissure or crack through the cross-section. These sections have been X-rayed at various angles, and it has not been possible for us definitely to relate the leaky condition under test with any defect observable under the X-ray.

In the section marked "2" in Fig. 11 there is no evidence of cavities, porous spots or cracks, and yet this section showed definite leak under the 50-lb. pressure test previously referred to.

Much of this work was carried on under or reviewed by Mr. Lester, and there is no question but that the X-ray technique employed is free from criticism. We feel that these illustrations may serve to direct attention to conditions which are well worth careful attention on the part of the Society's Committee E-7 on Radiographic Testing if the X-ray is to serve its proper place in industry as an inspection and development tool.

We also desire to add a word of emphasis to the use of the X-ray as a development tool. There are numerous instances wherein destructive testing is not advisable or is too expensive, in which the X-ray provides the only logical means for gaging progress and the development of sound molding methods.

Of fair and proper X-ray tests, applied to certain types of castings, the competent foundryman has or should have no fear. Much harm can accrue to industry as a whole if radiographic inspection is imposed on castings or structures in cases in which there is neither justification nor necessity.

Quality of Materials Discussed at New York Meeting

A TALK on "The Quality of Materials" by Dr. Stroud Jordan, Chief, Bureau of Standardization, Department of Purchase, Central Testing Laboratory, City of New York, was the feature of the meeting held at the Hotel New Yorker on Thursday, November 17, under the sponsorship of the New York District Committee. There was a good attendance, about 200 members and their associates and guests, including several ladies, being present. Prior to the meeting, most of the members of the New York District Committee and some guests entertained Doctor Jordan at a dinner.

J. R. Townsend, Materials Standards Engineer, Bell Telephone Laboratories, Inc., chairman of the New York District, presided. He introduced the Secretary-Treasurer, C. L. Warwick, who conveyed the regrets of President Delbridge, who was unable to be present. In commenting on various phases of the Society's work and particularly its growth, he mentioned that in connection with the new publication setup to go into effect in 1939, comparisons had been made of the number of standards and tentative standards in effect in 1927 and in 1938, also the volume of material in the *Proceedings* and BULLETIN and other items, in all of which there was a very heavy increase and that these studies showed members today were receiving at least 50 per cent more by way of standards, committee reports, technical papers, etc., than they did ten years ago.

After Mr. Warwick's brief talk the speaker of the evening, Doctor Jordan, was introduced. Doctor Jordan is in charge of testing materials and products purchased by the City of New York, the preparation of specification requirements, and carries out investigations on materials. He makes extensive use of A.S.T.M. specifications and has had a wide experience in the use of these specifications in the purchase and control of materials. His talk covered specifications and their value and use in the purchase and control in the quality of materials. He covered a number of pertinent points in connection with writing specifications and some of the problems involved and discussed in detail certain A.S.T.M. specifications, asking a number of questions about them. There was a great deal of very interesting discussion from the floor on several of the points in Doctor Jordan's talk and because many members should be interested in these, it is planned to include in the January BULLETIN a more detailed account of Doctor Jordan's presentation.

General arrangements for the meeting were made by Mr. Townsend in cooperation with G. O. Hiers, Chemist, National Lead Co., secretary of the District Committee.

Amphitheatre in Riverside Park, Columbus, a two mile long civic recreational development running north on the east side of the Scioto River. (See page one.)

Service Tests for Packings[1]

By F. C. Thorn[2]

THE name of the Society implies an association of people interested in testing materials. Testing is not, as some mistakenly suppose, limited to tests for composition, tensile strength and other items which compose the bulk of acceptance specifications.

As a matter of fact, the ultimate test for everything is service. Any other kind of test needs to correlate with service. But genuine service tests suffer from the disadvantage that they cannot be exactly reproduced. A pump or an engine never retraces any cycle in its history. The parts are worn more than before, or the pressures and temperatures are slightly different, or the number of starts and stops are more or less than before. These variations tend to make the verdict of service tests unfair in many specific instances. Therefore, while not underrating the importance of service results from a statistical angle, there is a real need for testing machines which incorporate the essential features of service in a controlled and reproducible manner. This paper deals with machines of that type.

Packings may be divided into (*a*) gaskets, (*b*) diaphragms, (*c*) sliding contact packings, rotary type, (*d*) sliding contact packings, reciprocating type, (*e*) valve disks.

GASKETS

Regarding gaskets, it has always seemed to me that the fundamental property of a gasket is to make a fluid-tight joint initially and keep it tight thereafter. The latter implies some degree of elastic recovery from compression, to keep pace with joint movement. The A.S.T.M. compression set test,[3] in my opinion, measures the wrong property—it measures the net change in shape, whereas what we are interested in is the recovery from maximum compression. Furthermore, the shape of the specimen, the temperature, the pressure, and the duration are all rather remotely related to conventional gasket practice. To get somewhat closer to service conditions we evolved the apparatus shown in Fig. 1. A disk of packing material, 1 sq. in. in area by $\frac{1}{8}$ in. thick, is compressed between platens with the aid of the air-ram shown. The platens are arranged for steam heating, and equipped with dual micrometers to measure compression and recovery. We work generally at 2000-lb. pressure, apply the load cold, note the compression, turn atmospheric steam into the platens, note the further compression in 24 hr., release the pressure and note the recovery. In Fig. 2 are shown typical curves for a rubber sheet, and a compressed asbestos sheet, both taken from an earlier article.[4]

The test, as it stands, is obviously imperfect. The temperatures should be higher and the duration longer. More delicate micrometers are needed to detect the slight recoveries which take place after such drastic treatment. Recoveries of 0.0001 in. are significant and should be capable of measurement. The air ram should be replaced by a frictionless mechanism. It is hoped that somebody will tackle the job of developing a better gasket testing machine.

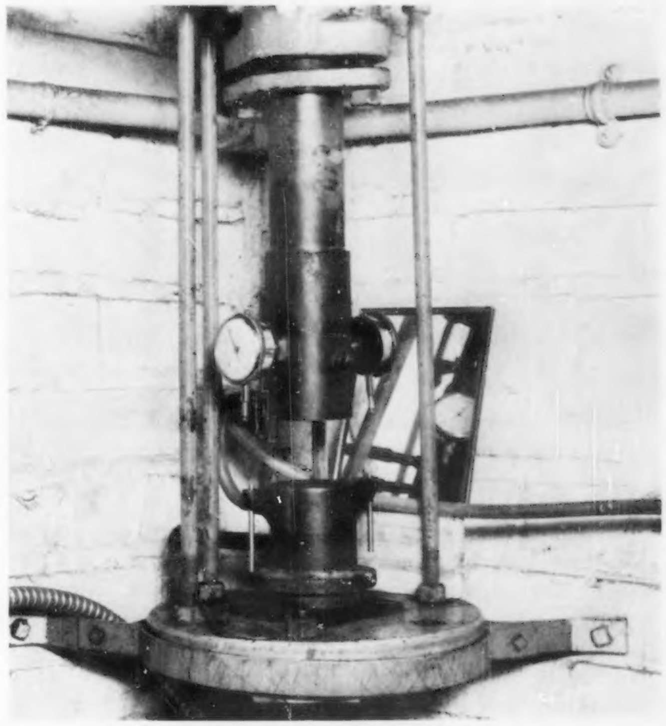
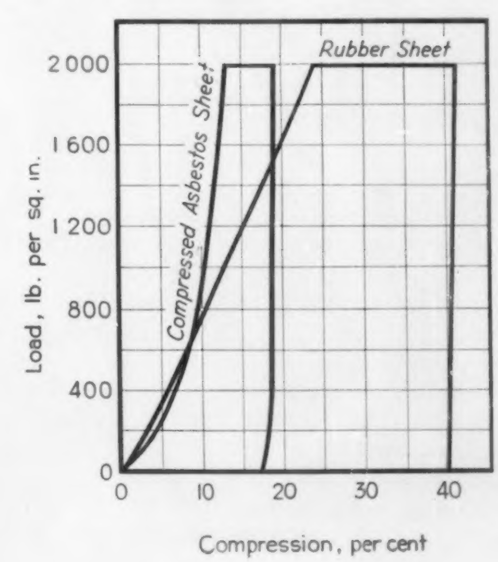


Fig. 1

We have a variation of the above machine in which a ring gasket is employed and a fluid under pressure is introduced into the interior through passages in the platens. This machine does not give much additional information unless the

Fig. 2



[1] Presented at a meeting of Subcommittee VI on Packings, Gaskets and Pump Valves, Committee D-11 on Rubber Products, Atlantic City, N. J., June 29, 1938.

[2] Chief Chemist, Garlock Packing Co., Palmyra, N. Y.

[3] Tentative Method of Test for Compression Set of Vulcanized Rubber (D 395 – 37 T), *Proceedings*, Am. Soc. Testing Mats., Vol. 37, Part I, p. 1127 (1937); also 1937 Book of A.S.T.M. Tentative Standards, p. 1299.

[4] F. C. Thorn, "Gaskets," *Journal of Industrial and Engineering Chemistry*, Vol. 28, No. 2, p. 164 (1936).

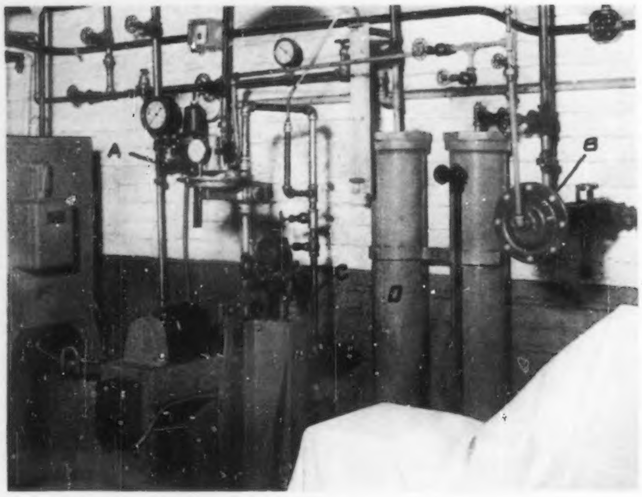


Fig. 3

gasketing is very rough-surfaced or porous. It is used practically to test paper gasketing for kerosine seepage.

DIAPHRAGMS

In Fig. 3 are shown arrangements for testing diaphragms for their two fundamental properties—hysteresis and fatigue. The gas regulator diaphragm *A* is being tested for hysteresis. To this end, air pressure is admitted to the regulator in graduated steps, and readings taken on the stem position by the pair of micrometers shown. Then the air is released by steps and another set of readings taken. In Fig. 4 the two sets of readings are plotted to form a loop,

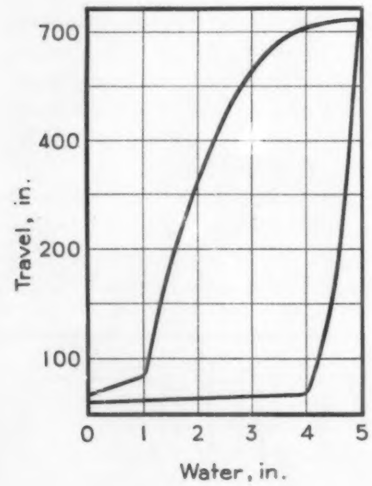


Fig. 4

the width of which gives a measure of the error in downstream pressure occasioned by the friction of the diaphragm. The loop is wide in the instance shown, which shows that the diaphragm is poorly suited for the service. On the other hand, the same diaphragm was rendered fairly satisfactory by a change in the shape of the piston in the regulator. This shows how hard it is to divorce the properties of the material from the design of the equipment in which it is to be used.

The control valve diaphragm *B*, in Fig. 3, is being tested for fatigue. To this end, it is supplied, for months at a time, with a pulsating air flow from the motor-driven three-way air valve *C*. To make the service harder, the valve may be supplied with gasoline instead of air by the medium of the U-shaped siphon shown at *D*, or the whole valve may be enclosed in the special steam-heated oven shown at *E* and supplied with a pulsating flow of hot oil. If desired, it can be mounted in the oven shown at *F* and operated in an atmosphere of air at any temperature up to 300 F., to simulate the effect of radiant heat from a steam line. A diaphragm must be of very good quality to withstand many hours of such treatment.

The fatigue test may be interrupted at any time to conduct a hysteresis test, for which a micrometer is mounted on the

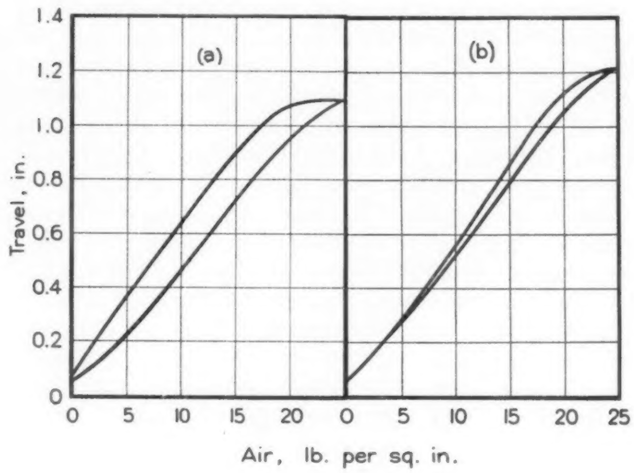


Fig. 5

stem, and a manometer to measure pressures is provided immediately adjacent. Of course, if one is getting the hysteresis of the diaphragm, no packing is used in the stuffing box of the valve-body. If packing were included, the combined hysteresis of the packing and the diaphragm would be obtained. In Fig. 5 are shown hysteresis loops taken with two different stem packings, the test being taken after several hundred hours of operation on a steam line. The superiority

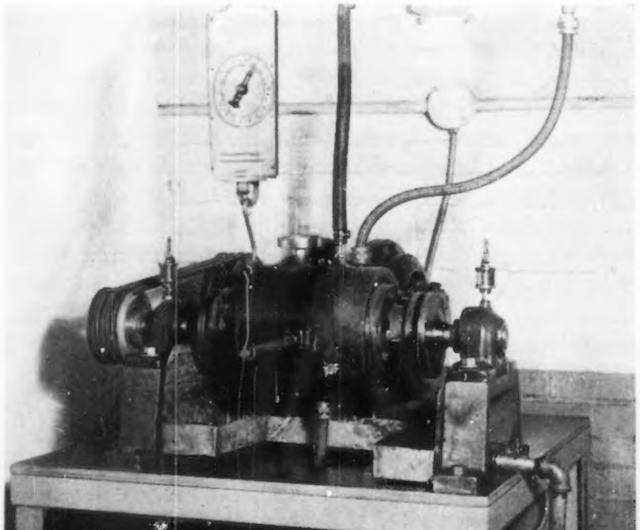


Fig. 6

of the second packing is evident. This leads to a discussion of sliding contact packings.

SLIDING CONTACT PACKINGS—ROTARY TYPE

Regarding sliding contact packings for pumps, most consistent results have been obtained in testing the centrifugal type. The machine shown in Fig. 6 represents our latest and best design. It consists of a barrel provided with internal bearings and conventional stuffing boxes at either end. The barrel floats on a shaft which can be rotated at the desired speed. The barrel is filled, through the hose connection shown, with a chosen fluid and maintained at a given pressure. A

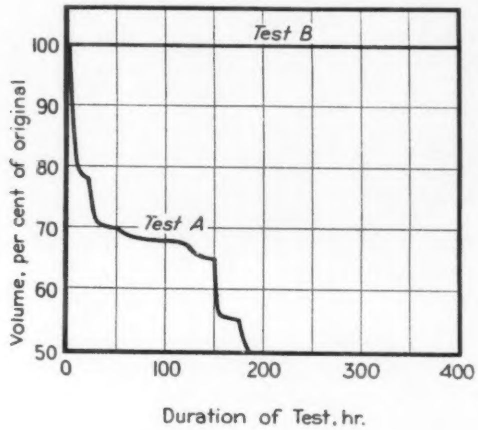


Fig. 7

specified temperature can be maintained by passing steam, or water, through the jacket. The torque is measured by the spring balance and corrected for the bearing friction. The leakage is collected and measured. It is customary to operate with a fixed leakage rate, the gland bolts being tightened as necessary.

In Fig. 7 is shown the log of a test run on braided asbestos packing against hot water at 1800 r.p.m., the volume of the packing being plotted against the hours. In test *A* the water leak was reduced until it became invisible due to flashing into steam as fast as it reached the atmosphere. The packing failed in a comparatively short time, the loss of volume following an "S" curve which is characteristic for this type of material. In test *B* a leak of about 2 drops per second was permitted. No change of volume took place within the limits of the chart. In Fig. 8 are shown the fric-

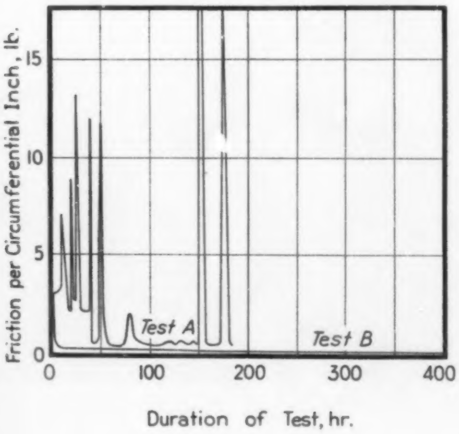


Fig. 8

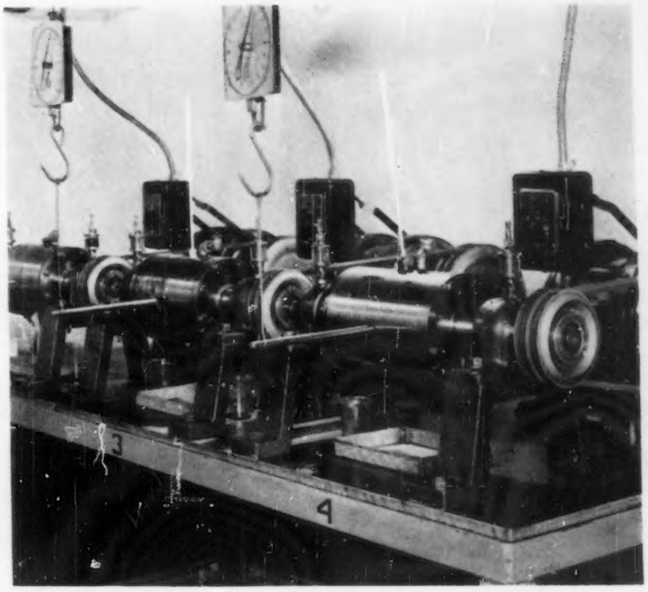


Fig. 9

tion logs for the same tests, converted to pounds per circumferential inch per stuffing box. The frequent seizures which occurred in test *A* and the complete absence of them in test *B* will be noted. This emphasizes again that there is no such thing as a "good" or a "bad" packing in the abstract. A packing is good or bad only in relation to the equipment in which it is to be used and the manner in which it is to be adjusted.

The versatility of the machine is shown by the fact that it can also be used to test packings against kerosine at 300 F. and 100-lb. pressure, to simulate the conditions that prevail

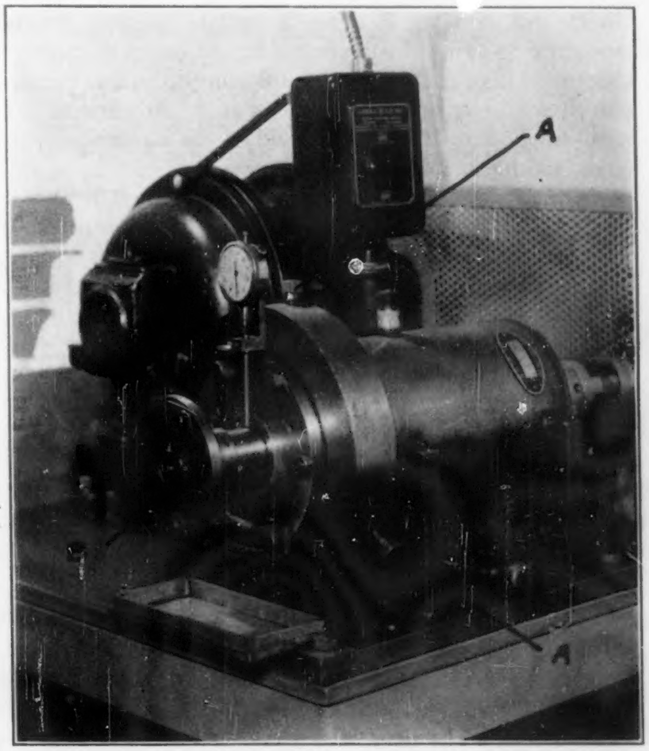


Fig. 10

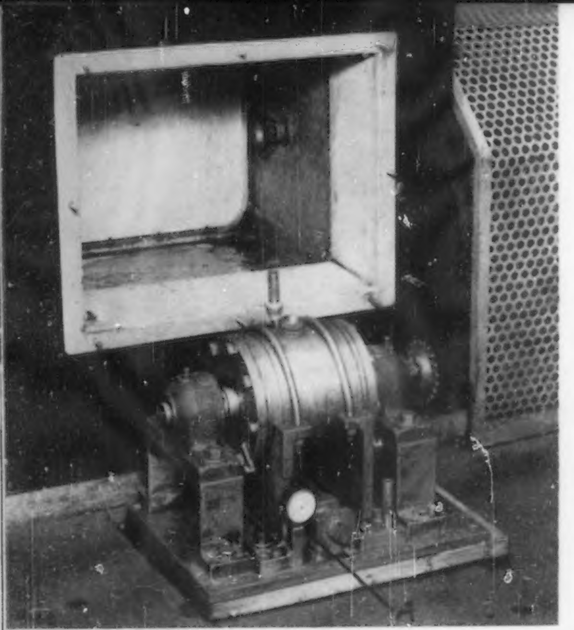


Fig. 11

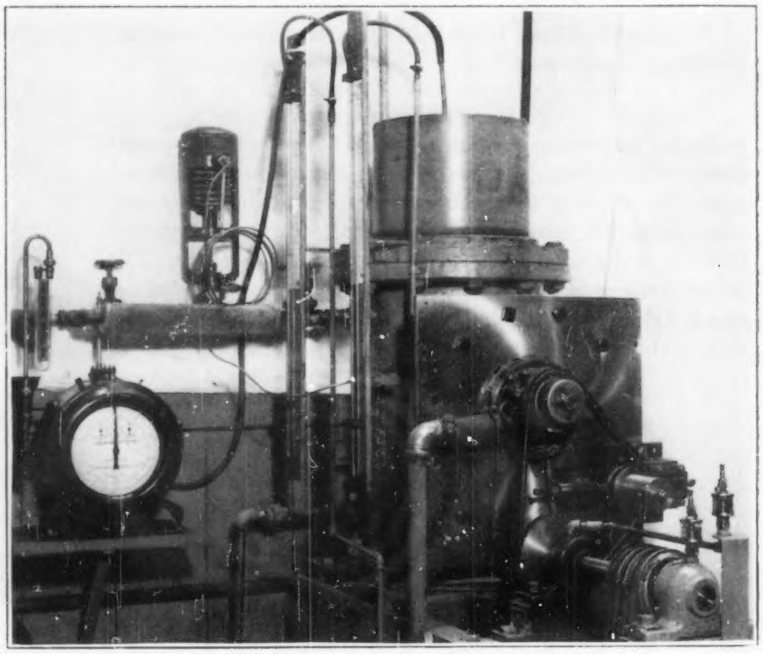


Fig. 12

in the charging pumps used in connection with cracking stills.

By a simple modification, as shown in Fig. 9, the machines can be made to test the self-contained packings known generally as "rotary seals." These seals are of rubber, synthetic rubber, cork, leather, bakelite and metal. Packing is a functional material, and rubber packings have to be considered in the same class with all sorts of other types that compete with them for the same job.

Another thing we can do with these machines is to install eccentric wear sleeves and get the effect of a gyrating shaft. In Fig. 10, however, is shown a machine specially designed for gyrating work. In this machine, the barrel is stationary, but the bearing at the near end is floating on rubber bumpers, which are directly under the screws at *A*. Any desired gyration can be produced with the aid of the eccentric flywheel at *B*, and measured by the micrometer.

In the machine shown in Fig. 11, the barrel is also stationary, but can be laterally displaced to any desired extent by the screw and micrometer shown at *A*. This tests the effect of a shaft permanently off-center, or occasionally shifted. In the rear is a cold cabinet, remodeled from an ice cream can holder. Zero temperatures lessen the ability of a packing to accommodate itself to a shifting shaft.

In Fig. 12 is shown a specialized machine for testing automobile water pump packings. Not only is the speed controlled, but also the belt tension, the temperature of the fluid being handled, and the pressures in front of and behind the pump. Air leakage is measured by the meter shown, after being collected in a diving bell mounted over the pump discharge.

SLIDING CONTACT PACKINGS—RECIPROCATING TYPE

In the field of reciprocating packings, we have not been quite so successful in getting reproducible results. The machine shown in Fig. 13 is set up to test packings on hydraulic water service. The shaft is driven by a crank mechanism in the rear, not shown. The same apparatus can be used to test steam-engine packings. The principal difficulty in getting reproducible results is to duplicate exactly the leakage. The leakage is very important, but difficult to collect and measure. The calibrated springs shown are useful in controlling the gland pressure.

VALVE DISKS

For testing pump valves, we have experimented some with a machine developed at the U. S. Rubber Co. laboratories, consisting of a punch press carrying with it a replica of a grid seat, the valve disk itself being carried on heavy car springs, the tension of which controls the force of the blow. We have not obtained satisfactory results due to the absence of a liquid "wire-drawing" effect, which seems to be an important factor in service failures. We avoid this difficulty in testing small valve disks by the "rocker-arm" machine

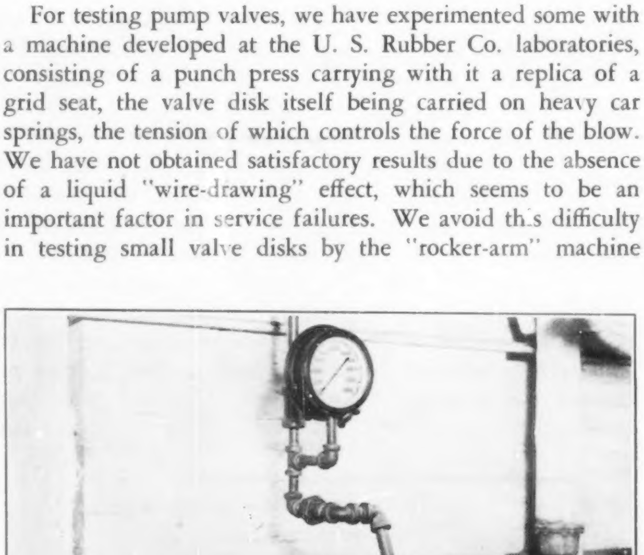


Fig. 13

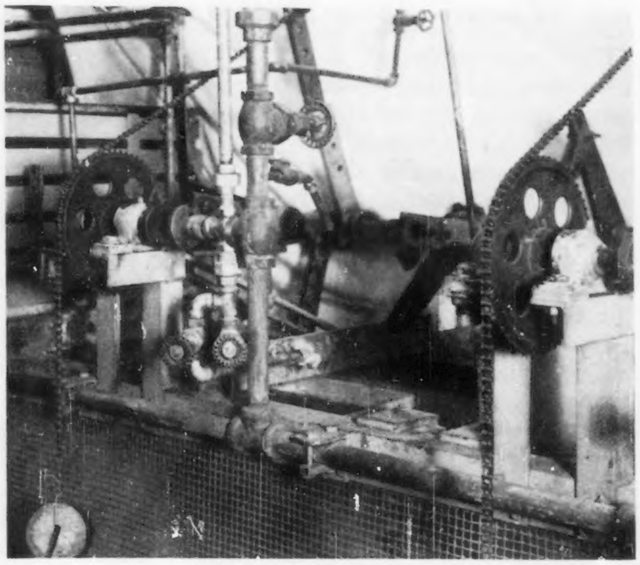


Fig. 14

shown in Fig. 14. The valves are opened and closed by a chain running over a sprocket, the jack-shaft serving to take any lateral strains off the valve stem proper. The fluid under test escapes each time the valve disk is raised. The machine is shown at work testing bibb-washers on a common compression stop. Alongside it is a globe valve awaiting test on steam at 550 F. The same machine is very useful for testing stem packings and a variety of small equipment such as shock absorbers and swing joints.

This presentation has been limited to discussion of the more generalized type of service testing equipment for packings which, it is believed, should be of broad applicability and more immediate interest. Many other specialized tests and machines have been devised and constructed for specific purposes.

It is realized that there is a great deal of excellent work being done along these lines in other laboratories and it is hoped that some papers will be forthcoming describing some of this. It is also hoped that some of the larger packing users may find it to their advantage to install some of this equipment, if they have not already done so. In arriving at the proper clauses to appear in an acceptance specification, the verdict of these machines cannot be ignored. The more such machines we have, the surer we will be to arrive at rational packing specifications.

Emergency Bulletin Regarding Standard Testing Sand

THE standard specifications for portland cement require the use of Ottawa sand, prepared by the Ottawa Silica Sand Co. for mortar test pieces. Due to labor difficulties, this company is not now able to supply sand for this purpose and this interruption may last for a considerable time.

At the recent meeting of Committee C-1 on Cement, the chairmen of the sponsoring committees for the various cements were asked to prepare this statement, in order to suggest to users of standard sand means for securing testing sand until the regular supply again becomes available. There has not been time to prepare recommendations that are entirely satisfactory, but the following seems to be the best procedure for the present.

It is suggested that laboratories prepare from such satisfactory local supplies as may be available sand of the same grading as is required by the standard specifications. This sand should be tested in standard briquettes, in comparison with remaining supplies of standard Ottawa sand, and a factor should be established for each age of test. It also seems desirable to establish separate factors for high-early-strength cement and standard cement.

If no satisfactory sands are available locally, we can refer users to the Tamms Silica Company, 228 N. LaSalle St., Chicago, and to the Wedron Silica Sand Company, Wedron, Ill. Both of these companies draw their sand from the same deposits as are being worked by the Ottawa Silica Sand Co.

We understand that the Tamms Silica Co. is prepared to supply limited quantities of fully processed testing sand. The Wedron Silica Sand Co. has a standard product which contains about 45 per cent of the 20-30 fraction. We understand that they are not at present prepared to ship this sand in small quantities but are investigating this possibility and also the possibilities of shipping fully processed 20-30 testing sand.

Even though the above-named concerns or others supply sand that is fully processed, we recommend that until the characteristics of the sand so processed are fully established, users follow the procedure suggested in the early part of this statement.

H. D. Baylor W. H. Klein M. A. Swayze

Chairmen of Cement Sponsoring Committees of Committee C-1

Comments on Proposed Standards

ONE of the basic principles underlying the development of A.S.T.M. standards is that *everyone* interested in a specification or test method shall have an opportunity to participate in its development—by expressing viewpoints in committees and before the Society, or presenting data relevant to the subject considered or in other ways.

During September and October, the tentative standards which were approved at the annual meeting or by Committee E-10 on Standards are edited and published. In order to stimulate comment and criticism these are brought to the attention of trade associations and other organizations interested, business journals, and, of course, their widespread use in the various phases of production and consumption tend to stimulate comment.

One purpose in issuing proposed standards in tentative form is to elicit constructive criticism and comment, of which the standing committees in charge take due cognizance before recommending adoption as a formal standard. In this connection each A.S.T.M. member can be of service by reviewing critically tentative standards in which he or his company is interested or by bringing them to the attention of other interested parties, to the end that finally a standard will be adopted which will represent a true consensus of industry, be practical, complete and authoritative. Comments should be forwarded to Society Headquarters.

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No. 95 December, 1938

District Meeting Values

NEWS articles in this issue describing recent district meetings in Philadelphia, Pittsburgh, and New York focus attention on some of their very valuable contributions. First of all, the district committees sponsoring them have adopted the general policy of having one or two outstanding meetings during the year rather than to hold them more frequently, realizing that members have a limited amount of time since most have their professional group and other sessions to attend. This premise results in technical contributions which are of distinct interest and of value, not only to those attending, but to many others who procure the publications in case the papers are issued in special form. Symposiums on pearlitic malleable iron, industrial fuels, wear testing of metals, protecting metals against corrosion are titles of some of the publications which have resulted from local meetings. Each has been very favorably received by engineers concerned with the fields covered.

Distinct from their technical value is the opportunity afforded members in industrial centers to fraternize with others, meet the Society officers and members of the district committees and especially to bring their associates and friends, thus acquainting them with some of the workings of A.S.T.M. Many members find it impossible to attend regularly the annual and regional meetings, so that local meetings serve a very important purpose in this respect.

Every meeting that has been held has served to promote a feeling of solidarity on the part of members, to focus attention on A.S.T.M. work in a particular district and to acquaint individuals and companies not already represented in the Society with the inherent value of our standardization and research activities.

These meetings deserve the support of all members in the respective districts. The manner in which they have developed since the district committees were formally organized in 1933 and their importance in forwarding the work of the Society is distinctly encouraging. They occupy a very important place in the Society's activities. Members can derive a good deal from attending them whenever possible.

Wanted—More Student Members

THE total number of students in various engineering schools and colleges who hold membership in the Society is close to 350, but of this number over 90 per cent are located in only 16 schools. A recent discussion of the value of student membership developed a consensus that there should be many more students holding this class of membership in the Society with a more diversified representation of schools. The sentiment was expressed that if the matter were brought to the attention of a number of members of the Society, they might wish to see whether their Alma Mater is represented in the list and if not, whether students taking certain courses would not benefit from affiliation with the Society.

There follows a list of schools with four or more student memberships:

College of the City of New York	91
Ohio State University	73
Pratt Institute	31
University of Colorado	27
University of Delaware	22
Rensselaer Polytechnic Institute	17
Grove City College	11
University of Pennsylvania	11
Detroit Institute of Technology	10
Cornell University	9
University of Kansas	9
University of Illinois	7
University of Idaho	6
Iowa State College	5
Polytechnic Institute of Brooklyn	4
University of Michigan	4

This list needs some explanation which can best be given by indicating the publications which student members receive or which they can purchase at greatly reduced prices. Each student gets the ASTM BULLETIN. He can obtain a copy of the Year Book and preprints of the large number of technical papers, reports, etc., presented at meetings (some 1000 pages). In addition, he may select any one of the special compilations of standards which cover such fields as petroleum products, rubber products, refractories, textiles, etc., or the compilation of Selected Standards for Students which has been designed especially for use in courses involving engineering materials. The Society also makes available for educational use many of its volumes including the Book of Standards at greatly reduced prices.

This publication setup will explain to some extent the number of student memberships at certain of the schools where engineering departments use A.S.T.M. publications such as the Book of Standards. Students by becoming members can procure the books at the reduced prices. At the same time they receive the other benefits from affiliation with the Society.

One other factor also affects the number of students at certain schools, namely, the Student Membership Prize Award plan which has been in effect several years. This provides that outstanding students are awarded student memberships as prizes, these being underwritten by members of the Society. This prize award plan is in effect in several engineering schools where from three to ten awards are made annually in accordance with recommendations submitted by the dean of engineering or professors in charge of

certain courses. The basis of the award is worked out usually by the donor and the faculty.

The only fees in connection with student membership are the annual dues of $1.50. A great many students use in their course in testing laboratory and others, the compilation giving Selected Standards for Students and if a student has purchased this book, which is furnished at 50 cents per copy (213 pages), this sum is refunded so that his dues are only $1.00 for the year.

Membership in the Society should be of real benefit to the young engineer, assisting him in keeping abreast of the advancing knowledge in the field of materials, giving him a working idea of the properties covered in standard specifications of quality and impressing him with the importance of standardized methods of testing procedures, physical, chemical, metallurgical, optical, etc.

From the standpoint of the Society, student membership is desirable because it insures that future engineers will have a knowledge of the value of Society work. Records indicate that quite a number of the students continue their affiliation with the Society after their college years as junior members and later, depending on their industrial work, may become members or representatives of company memberships.

Student membership application blanks are available at Society Headquarters and will be sent on request. Full details of the Student Membership Prize Award plan will also be gladly furnished.

Multiple Purpose Standards

Two recent occurrences illustrate the statement that "while standard specifications and tests are designed usually to meet a particular need of industry, you never can tell what other useful purpose they may serve or fields where they can be incorporated."

A short article in this issue points to the use of A.S.T.M. standards in the regulations governing design and construction of public school buildings in California. There are a great many state and municipal building codes, particularly the more modern ones, which do make extensive use of the Society's specifications and tests. Many of these codes have been in existence for long periods of time and are revised as the need arises, but in the case of the public school building regulations, the requirements had to be drafted very promptly and if those responsible had been forced to assume the tremendous task of developing adequate quality requirements for the numerous materials covered, how much more time would have been required. Probably no one on the A.S.T.M. committees responsible for these specifications visualized that the work they were doing would be of inestimable benefit in protecting school children against possible disaster.

Another recent occurrence—a body of scientists working on important problems in the field of biology are concerned with certain physical and chemical tests of materials and it is probable that several of the A.S.T.M. standard methods of procedure may serve this group very effectively in advancing their program. Some modifications may be necessary, but nevertheless the great amount of effort put on the standards by the committee members of the Society will not need to be duplicated in this other endeavor.

We are impressed by the wide range of useful possibilities for the A.S.T.M. specifications and tests.

Offers of Annual Meeting Papers

Committee E-6 on Papers and Publications is extending to each member of the Society the customary invitation to offer papers for presentation at the 1939 annual meeting in Atlantic City on subjects relating to the properties and testing of engineering materials.

In order that as many as possible of the technical papers and committee reports can be preprinted in advance of the meeting, it is desirable that the program be developed early. Committee E-6 has fixed February 15 as the limiting date for receipt of offers but members who may be considering the submission of a paper are urged to send their offers to A.S.T.M. headquarters *as soon as possible.* Suitable blanks which should be used in sending the necessary information with respect to the offer of a paper can be obtained from Society headquarters. Each offer must be accompanied by a summary of the proposed paper in such detail that its scope is clear and also to point out features that in the author's opinion make the paper a desirable one for presentation and discussion.

Invitations to submit papers are not limited to A.S.T.M. members, many outstanding technical contributions to our *Proceedings* having been made by men who were not affiliated with the Society.

The Committee on Papers and Publications in its review of the papers offered endeavors to develop a balanced technical program. The committee welcomes suggestions of pertinent subjects from members who may not wish to offer papers.

It is important that each member of the Society or company representative mail promptly to A.S.T.M. headquarters the return card on which can be designated which parts of the 1939 Book of Standards and Tentative Standards are desired. If the card has been mislaid, a letter giving the information should be directed to Headquarters.

Committee D-13 Holds Outstanding Meeting

COMMITTEE D-13 on Textile Materials held its regular fall meeting in New York City, October 19 to 21, inclusive. The meeting was one of the largest and best ever held by the committee, with 106 members and 62 guests present.

The main committee held one general session and 19 of the 25 subcommittees held meetings with a good attendance reported at each.

One of the main technical features was the Symposium on Spun Rayon and Blended Fibers in which the following papers were presented:

- RAYON STAPLE MANUFACTURE—Frederick Bonnet, American Viscose Corp.,
- TEST METHODS—Harold DeW. Smith, A. M. Tenney Associates,
- PROCESSING OF SPUN RAYON AND SPUN RAYON MIXTURES—William H. Cady, United States Finishing Co.,
- FABRICATION, MERCHANDISING AND CONSTRUCTION OF SPUN RAYON AND BLENDED FABRICS—Alexis Sommaripa, E. I. du Pont de Nemours and Co., Inc.,
- THE ECONOMIC SIGNIFICANCE OF RAYON STAPLE FIBER—A FEW OBSERVATIONS ON THE INDUSTRY HERE AND ABROAD—Stanley B. Hunt, Textile Economics Bureau, Inc.

In conjunction with the symposium which was exceptionally well attended there was an exhibit of staple fiber and spun rayon, sponsored by the *Rayon Textile Monthly*. This afforded an excellent opportunity to compare all types of staple, both domestic and foreign.

On Thursday evening, October 20, a banquet was held followed by a paper on glass fiber and textiles by E. R. Shand, Corning Glass Works.

It was announced that the 1939 spring meeting would be held in Providence, R. I., March 1 to 3. This will be the Silver Anniversary of the formation of the committee and a special program is planned.

The arrangements for the series of meetings in New York were in the charge of Horace J. Jaquith, Minot, Hooper & Co.

RECOMMENDATIONS AFFECTING STANDARDS

At the meetings a number of actions were taken on standards under the jurisdiction of the committee, the various recommendations being approved for submission to letter ballot. It was decided to recommend the adoption as standard of the Tenative Method of Test for Shrinkage in Laundering of Silk and Rayon Woven Broad Goods, D 416 – 35 T, with the title changed to read "Standard Method of Test for Determining Maximum Residual Shrinkage in Silk and Rayon Fabrics," and the Tentative Method of Test for Fastness of Colored Textile Fabrics to Light, D 506 – 38 T, with minor revisions.

Revisions were recommended in the following:

- Methods of Testing and Tolerances for Hose Ducks and Belt Ducks (D 181 – 36)
- Specifications and Tolerances for Number Cotton Duck (D 230 – 27)
- Methods of Testing and Tolerances for Rayon (D 258 – 37 T)
- Methods of Testing and Tolerances for Knit Goods (D 231 – 33)
- Tongue Method for Tearing Strength in General Methods of Testing Woven Textile Fabrics (D 39 – 38)
- Specifications and Methods of Test for Osnaburg Cement Sacks (D 205 – 27)

WORK IN PROGRESS

The committee has a large number of projects being carried on in the various subcommittees and their respective sections. These include the development of methods of test for the following: rayon staple; laboratory sampling method for wool shrinkage determination; absorption qualities of felt; dimensions of felt cut parts; density of felt; diameter of drilled or punched felt wicking; swell and shrinkage of felt; asbestos cloth; single jute yarn; water absorption of terry toweling; measurement of mercerization; physical and chemical methods of testing glass roving, yarn, twine and fabrics; quantitative analysis of fabrics composed of wool and lanital; accelerated aging test for textiles; water resistance of textiles; fluidity of dispersions of cellulose fibers in cuprammonium hydroxide.

Work is under way in the development of specifications for fineness of wool tops, 48's to 36's; upholstery materials; plied cotton broadcloths; and household blankets.

A study is being made of definitions relating particularly to wool, felt, floor coverings, bast and leaf fibers and their products, and glass fiber products.

Important studies are being carried out on the following matters: moisture regain in heavy woven fabrics; type of gage for thickness measurements on tapes; consumer wear tests on rayon fabrics; resistance to slippage, seam unraveling, shrinkage and resistance to wrinkling of rayon fabrics; hydrochloric acid-soluble test for felt; sensitivity of type A testing machines; effect of rate-of-loading on strength of yarns as determined on type B machines; calibration methods for dead-weight dial micrometers; method of conditioning test specimens in the standard atmosphere; moth repellency; development of specifications for yarn reels and twist testers.

Committee on Soaps Has Active Meeting

AT a very interesting series of committee meetings held in New York City on October 31 and November 1, Committee D-12 on Soaps and Other Detergents approved a number of constructive actions in its work involving the formulation of specifications, methods of tests and definitions pertaining to soaps and detergents including the materials entering into their manufacture. All of the actions taken affecting new specifications or changes in existing items will be referred to the Society for approval prior to their official publication.

All told there were some 15 meetings of the main committee and its subcommittees and their sections.

As a result of the work of Committee D-12, the Society has already issued eight specifications; four methods of testing covering particle size, sampling and chemical analysis of soap and soap products, analysis of sulfonated oils and chemical analysis of special detergents; also several definitions covering terms relating to soaps and detergents.

The section on specifications for sulfonated detergents (J. B. Crowe, General Engineering Division, Procter & Gamble Co., chairman) is carrying out a series of comparative washing tests on soiled cloth to develop some satisfactory method of measuring detergency. The work on standardized

requirements for special detergents was advanced by approving proposed specifications for trisodium phosphate and sodium metasilicate developed by a section on special detergents (C. C. Ziegler, Swift and Co., chairman).

At the meeting of the group concerned with methods of testing special detergents (W. H. Koch, Mathieson Alkali Works, Inc., chairman) there was discussion of work under way in preparing methods of analysis for trisodium phosphate and sodium metasilicate and methods of test for carbon dioxide were also reviewed.

The section on tests for soaps (M. L. Sheely, chairman, representing American Oil Chemists Society) is working on the McNicoll method for rosin in soaps, and has developed some very interesting results. The members are also doing cooperative work on the carbon dioxide determination in soaps, but since not all the collaborators had reported on the cooperative samples, the report was one of progress to be completed before the 1939 spring meeting. This section also discussed water insoluble matter in soap; Wijs iodine test, etc.

Consideration of the existing Tentative Specifications for Chip Soap (D 496 – 38 T) and for Powdered Laundry Soap (D 498 – 38 T) by the subcommittee on specifications for straight soaps (Israel Katz, J. Eavenson & Sons, chairman) resulted in the recommendation to eliminate the word "laundry" in the specifications and under the scope clause substituting the following paragraph for the existing one:

> These specifications cover chip soap (or powdered soap) suitable for washing, cleaning and scouring processes with soft water, when the presence of alkaline salts is not desirable.

The idea of these changes was to eliminate any idea that these soaps were suitable only for laundry purposes. This section also discussed soft soaps and green soap.

Committee D-12 has two committee sections on dry cleaning detergents—one concerned with methods of testing, the other, specifications, and at a joint meeting of these groups progress was made in drafting requirements for dry cleaning soaps and detergents.

Considerable progress was made in writing specifications for soap powders and built soaps by the section on these materials (Frederick Krassner, U. S. Navy, Naval Clothing Depot, chairman). The committee hopes to have complete specifications drafted for both of the items by the 1939 spring meeting of the committee. Requirements for these materials have been subject to much discussion because of divergent viewpoints, but the committee believes that many of these have now been reconciled.

Another difficult subject on which the committee is working is that of metal cleaners. A meeting of the section on these materials was held (J. C. Harris, Monsanto Chemical Co., chairman) and progress was reported. The committee in charge of developing specifications for textile soaps (C. L. Nutting, Arlington Mills, chairman) considered requirements for palm oil soap and as a result of discussion of a number of points this work was forwarded.

Subcommittee III on Nomenclature and Definitions (Frederick Kenney, Consulting Chemist, Stevenson Rd., Hewlett, N. Y., chairman) reported considerable progress in writing definitions, particularly on the controversial subject, soap powder. The Government specifications have called for a minimum of 15 per cent of soap in soap powders and yet there is a big field in which soap powders with lower soap content have been used. To iron out this difficulty, definitions have been proposed for consideration which in rough read as follows:

Built Soaps—to contain a minimum of 50 per cent of soap.
"Break" Soap Powders to contain 25 per cent to 50 per cent of soap.
Soap Powders to contain 15 per cent or 25 per cent of soap.
Soapy Washing Powder or Detergents to contain 2 per cent to 15 per cent soap.

There has been much confusion in the use of the terms soap powders, etc., and the committee believes that some such definition as proposed will clarify this condition.

The committee would welcome comments and suggestions on these proposed soap powder definitions from any interested parties. Comments can be sent direct to the chairman, Mr. Kenney, to the D-12 officers, or through the A.S.T.M. Headquarters Office.

General arrangements for these meetings of Committee D-12 were made by the chairman, H. P. Trevithick, New York Produce Exchange, 2 Broadway, N. Y. C., with B. S. Van Zile, Colgate-Palmolive-Peet Co., 105 Hudson St., Jersey City, N. J., secretary. F. W. Smither, National Bureau of Standards, Washington, D. C., is vice-chairman

Current Certainties

In a paper presented at the Twelfth Annual Business Conference of the New England Gas Association early this year and published in the *American Gas Journal,* March, 1938, Prof. Erwin H. Schell, in Charge of the Department of Business and Engineering Administration, Massachusetts Institute of Technology, discussed "Current Certainties in a Time of Low Visibility." Professor Schell pointed out that

> "Uncertainty is not new in human affairs. Since the beginning of time men have faced its presence and encompassed the difficulties which it has brought. They will do so again. The technique is simple. First, acknowledge its presence. Second, determine its scope and the extremes of its probable influence. Third, design a program with a flexibility which encloses these possibilities. Thus uncertainty becomes assimilated and the hazards of fear and of surprise removed."

He outlined and discussed five certainties.

First, *we are in the presence of constant and relatively rapid change.* Of course, change has always been with us. Yet to accept its presence is to establish our thinking on a dynamic rather than a static basis.

Second, *human wants are increasing both in variety and intensity at an unprecedented rate.* . . . Come weal, come woe, the manufacturer who prepares specifically to make constantly higher quality available at constantly lower outlay will assure the future security of his business. We know of no sounder principle than this.

Third, *organized research has become the dominant competitive weapon for the individual establishment.* And more than research, the development of a new idea from its genesis until the time when it meets the acclaim from the consumer is a fresh art, the knowledge of which is enabling many companies to establish entirely new competitive frontiers.

Fourth, *a major resource is increasingly to be found in the good will of vendor and of customer, of community and of the public, as well as of stockholder and of employee.* . . . Such resource cannot be purchased but must be earned. It is the reward of perspiration rather than persuasion, the derivatives of sincere effort rather than superficial flattery.

Fifth, *industry as it is now constituted and is now evolving must and surely will go on.* In no industrialized country, whatever its ideology, has manufacturing been excommunicated. . . . We live not only by the machine, but because of it. Future policy must therefore be one which, though flexible to change, is designed for continuity. To give up in despair is only to make way to another.

These five certainties—the increasing rate of change; the rapid growth of wants for the better and cheaper; the striking potency of research; the saving grace of good will; and the necessity of continuity—as they bear upon the industrial scene, are realities in which executives may place their trust. And to heed their presence is not only a privilege but a duty.

Research Committee on Effect of Temperature Meets in Columbus

At the well-attended meeting of the Joint A.S.T.M.-A.S.M.E. Research Committee on the Effect of Temperature on the Properties of Metals held at Battelle Memorial Institute in Columbus, Ohio, on November 18, two reports were approved for presentation on December 6 at the annual meeting of The American Society of Mechanical Engineers in New York City. The first report entitled "Creep in Tubular Pressure Vessels" was prepared by Dr. F. H. Norton, Massachusetts Institute of Technology. This covers the work of the committee's Project No. 10 on creep tests of tubular members subjected to internal pressure. The second report prepared by E. L. Robinson, General Electric Co., covers "The Resistance to Relaxation of Materials at High Temperature." This is the committee's Project No. 16 on Relaxation Tests.

The committee expects that final reports on two other projects will be presented at the 1939 A.S.T.M. Annual Meeting in June in Atlantic City. Covering Project No. 15 is the report "Torsion Creep Tests for Comparison with Tension Creep Tests on Carbon-Molybdenum Steel" by F. L. Everett and C. L. Clark, University of Michigan. The other report involving Project No. 17 on the study of high-temperature life-test methods will cover time relaxation tests which are being made at the University of Michigan.

The committee decided to arrange for a round table discussion at the A.S.T.M. annual meeting next June on experiences and problems at low temperatures, materials for low-temperature service, and testing procedures in this field. Arrangements for this discussion are in the charge of F. B. Foley of The Midvale Co., Philadelphia.

The committee also discussed the work of Project No. 18 dealing with the effects of manufacturing variables on the creep resistance of steels and has decided to continue these studies. The next problem to be investigated is that of deoxidation practices and grain structure in carbon steel and their effect on creep behavior.

H. J. French Honored

At a dinner held in his honor at the Faculty Club of Ohio State University following the meeting of the Joint Research Committee on Effect of Temperature on Metals in Columbus, Ohio, on November 18, H. J. French, In Charge, Alloy Steel and Iron Development, The International Nickel Co., Inc., past-chairman of the Joint Research Committee, who retired as chairman in June this year, was presented with a very nice gold watch in token of appreciation for his service as head of the committee from 1929 to 1938. There were about 25 members and associates present at the dinner. The watch was suitably engraved as follows:

To
Herbert J. French
in appreciation of his successful guidance
of the J.R.C.O.E.O.T.O.M.
A.S.T.M.—A.S.M.E.—1929—1938
From his co-workers
November 18, 1938

Schedule of Meetings

Date	Committee	Place
December 14	E-10 on Standards	Philadelphia, Pa.
January 16, 17	D-2 on Petroleum Products	Detroit, Mich.
January 23, 24	Executive Committee	Philadelphia, Pa.
January	A-1 on Steel	Philadelphia, Pa.
March 1-3	D-13 on Textile Materials	Providence, R. I.
March 6-10	Committee Week	Columbus, Ohio
March 8	Regional Meeting	Columbus, Ohio
June 26-30	42nd Annual Meeting and 5th Exhibit	Atlantic City, N. J.

Cement Committee Meets in Washington

A well-attended two day session of Committee C-1 on Cement was held in early November at the National Bureau of Standards in Washington. There were no actions affecting standards. The purpose of the meeting was to secure a general discussion of some of the questions now engaging the committee's attention, and to have the subcommittees meet and consider these questions and discussions between the sessions of the main committee. The meeting appeared to have realized its aim.

Among the questions considered were the following interesting items: specifications for blended cements, the matter of how many specifications for cement are needed, tests of additions in cement, specifications for low-heat cements, revision of specifications for masonry cement, methods for chemical determinations, and tests of "baby concrete" in 2-in. cube specimens. It is expected that definite recommendations on some of these subjects will be presented for consideration at the next meeting, which will probably be in the spring.

Work on Mortars Progresses

Committee C-12 on Mortars for Unit Masonry held a very well-attended meeting at the National Bureau of Standards in Washington on November 2. A proposed specification for sand for mortar was considered as part of the report of Subcommittee IV on Specifications for Sand for Mortar (Stanton Walker, chairman). It was voted to recommend publication of this specification as information in the ASTM Bulletin together with an abstract of the comments received. This recommendation is in line with the action previously taken on the report of Subcommittee II on Methods of Test (A. T. Goldbeck, chairman). (This report entitled "A Preliminary Consideration of Some Proposed Methods of Sampling and Testing Mortar for Unit Masonry" was published in the October Bulletin.)

Critical and detailed consideration was given to a draft of proposed specifications for mortar for unit masonry, submitted as information by Subcommittee III on Specifications for Mortar (T. I. Coe, chairman). Subcommittee III had requested this consideration by Committee C-12 as a whole for the purpose of ascertaining the committee's views on various items of the specification. The subcommittee will report again at the spring meeting of Committee C-12 with a revised draft of the specifications for mortar.

J. W. McBurney, Senior Technologist, National Bureau of Standards, Washington, D. C., chairman of Committee C-12, presided at the meeting with H. C. Plummer, Chief Engineer, Structural Clay Products Institute, Washington, D. C., secretary.

New Typographic Style Used in Publishing Standards

EACH member of the Society should have received his copy of the 1938 Supplement to the Book of A.S.T.M. Standards and the 1938 compilation of A.S.T.M. Standards on Petroleum Products and Lubricants has been shipped to those members who have ordered copies. Many members in examining the publications undoubtedly have noted a very decided difference in the format or typographic style used. The major change is printing the specifications and tests in the double column format rather than the single column used up to this year.

Some time ago, as a result of studies that were made, the several advantages of publishing papers and reports in double column format became apparent and certain special technical publications and the 1937 *Proceedings* were restyled. The very favorable reception led to additional studies of the possible advantages in restyling the standards and as a result of intensive work and consultation with the standing committee officers, the new style for standards was adopted.

One outstanding advantage of the new set-up is the considerable saving in amount of space required. By use of the two-column format an average saving of 20 per cent will be effected. This means that a 400-page book of the old style can now be issued as 320 pages. (This is approximately the case with the D-2 pamphlet.) Considering the large number of pages involved in the standards and tentative standards, this is a very considerable item.

Readability tests for speed and accuracy definitely were in favor of the two-column set-up. While rapidity of reading is perhaps more important in the case of reports and papers than in specifications, it is nevertheless significant. The accompanying facsimile shows the old and the new style. There has been a practically unanimous opinion that the new style is distinctly superior from the appearance standpoint.

Resetting all the specifications will incur a great deal of laborious checking, proofreading, etc., but it has the advantage of enabling a number of desirable editorial changes to be made in many of the specifications. Each standard is being studied in great detail in cooperation with committee officers and in many cases improvements will result by the use of some rephrasing making similar sections and requirements in different specifications alike, the use of clearer paragraph heads, etc. *One important fact should be brought to the attention of all members, namely, that in some standards section numbers will be changed.* In so far as possible, this is being avoided but in some cases uniformity is important and to achieve this certain sections may need renumbering.

TENTATIVE METHOD

FOR

CONVERSION OF KINEMATIC VISCOSITY TO SAYBOLT

UNIVERSAL VISCOSITY[1]

A.S.T.M. Designation: D 446 – 37 T

This is a **Tentative Standard** and under the Regulations of the Society is subject to annual revision. Suggestions for revision should be addressed to the Headquarters of the Society, 260 S. Broad St., Philadelphia, Pa.

ISSUED, 1937.

Scope

1. The conversion table and equation included in this method provide a means for converting kinematic viscosity in centistokes at any temperature to Saybolt Universal viscosity in seconds at the same temperature.[2,3]

Description

2. The Saybolt Universal viscosity equivalent to a given kinematic viscosity varies with the temperature at which the determination is made. The basic conversion values are those given in Table I for 100 F. The Saybolt Universal viscosity equivalent to a given kinematic viscosity at any temperature may be calculated as described in Section 3. Equivalent values at temperatures of 130 and 210 F. are given in Table I for convenience.

Procedure

3. For conversions at 100, 130 and 210 F., the equivalent Saybolt Universal viscosity values may be read directly from Table I. For kinematic viscosities between 2 and 70 centistokes which are not listed in Table I, the equivalent Saybolt Universal viscosity values may be obtained by linear interpolation. For kinematic viscosities over 70 centistokes, the Saybolt Universal viscosity equivalent may be calculated by use of the multiplication constant given in Table I corresponding to the proper temperature. The Saybolt Universal viscosity equivalent to a kinematic viscosity determined at t F. may be calculated by multiplying the equivalent Saybolt Universal viscosity at 100 F. by $1 + (t - 100)\ 0.000064$.

[1] Under the standardization procedure of the Society, this method is under the jurisdiction of the A.S.T.M. Committee D-2 on Petroleum Products and Lubricants.

[2] See paper by C. E. Headington and J. C. Geniesse, "Method for Converting Kinematic Viscosity to Saybolt Universal Viscosity," *Proceedings*, Am. Soc. Testing Mats., Vol. 37, Part I (1937).

[3] Extensive tables for converting centistokes to Saybolt Universal seconds are under preparation and when completed will be available from Society Headquarters, 260 S. Broad St., Philadelphia, Pa.

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Supplementary Conversion Equivalents

4. The following equivalents are frequently used in connection with viscosity conversions:

Poise	= c.g.s. unit of absolute viscosity
Centipoise	= 0.01 poise
Stoke	= c.g.s. unit of kinematic viscosity
Centistoke	= 0.01 stoke
Centipoises	= centistokes × density (at temperature under consideration)
Reyn (1 lb. sec. per sq. in.)	= 69 × 10[6] centipoises

[1] Under the standardization procedure of the Society, this method is under the jurisdiction of the A.S.T.M. Committee D-2 on Petroleum Products and Lubricants.

[2] See paper by C. E. Headington and J. C. Geniesse, "Method for Converting Kinematic Viscosity to Saybolt Universal Viscosity," *Proceedings*, Am. Soc. Testing Mats., Vol. 37, Part I, p. 380 (1937).

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OLD ENGLISH INSTRUMENTS

AN HISTORICAL CATALOGUE

NOWADAYS the study and collection of early apparatus of scientific interest has assumed considerable importance. The historical aspect of science has, in fact, never been so widely appreciated, and this is partly manifested in an increasing number of serious contributions to books and journals devoted to the subject.

Early instruments form a particularly valuable and fascinating study and the accompanying reproduction of an early catalogue is of considerable interest in view of the type of instrument then in use and the price at which it was sold. The catalogue is reproduced through the kindness of Mr. Thos. H. Court, the well-known authority on early scientific instruments, who has placed its date as 1764-5.

The catalogue contains a price list of early "Philosophical, Optical and Mathematical Instruments Made and Sold by BENJAMIN MARTIN, At his Shop, the Sign of Hadley's Quadrant and Visual-Glasses, near Crane-Court, in Fleet-Street." Included also are lists of books and prints published by the same person.

In reproducing this pamphlet it must not, of course, be thought that Martin was the only instrument maker of his day. Other well-known makers also lived about this time, amongst whom mention may be made of Moxon, Short, Dollond and Adams*. All these workers contributed to advances in construction of scientific instruments.

* See R. S. Clay and T. H. Court, 'Trans. Newcomen Soc., Vol. XVI, p. 45.

A Catalogue of Philoſophical, Optical, and Mathematical Inſtruments Made and Sold by

BENJAMIN MARTIN,

At his Shop, the Sign of Hadley's Quadrant *and* Viſual-Glaſſes, *near* Crane-Court, *in* Fleet-Street.

Philoſophical Inſtruments.	l.	s.	d.
LARGE Orreries from 40*l.* to	150	0	0
Cometarium	5	5	0
Senex's Globes 28 Inches Diameter, in Mahogany Frames, with carv'd Work and ſilver'd Meridians, &c.	35	0	0
Ditto, in Wainſcot Frames	26	15	0
17 Inches, ditto	6	6	0
12 Inches, ditto	3	3	0
9 Inches, ditto	2	2	0
3 Inches, ditto in a Caſe	0	10	0
A large ſtanding Air-pump	15	15	0
Apparatus to ditto, from 3*l.* 3*s.* to	12	12	0
Davenport's Table Air-pump, excluſive of Apparatus	10	10	0
Single barrell'd Air-pump	2	12	6
Apparatus to ditto	2	2	0
Electrical Machine in Braſs, with an Apparatus, Box, &c. from 5*l.* 5*s.* to	13	13	0
Beſt Sort of Barometer	1	11	6
Farenheit's Thermometer	1	16	0
Pocket ditto	1	1	0
Hydroſtatic Balance, Apparatus, &c.	1	15	0
Fountain in Copper, with Apparatus, from 5*l.* 5*s.* to	10	10	0
Small Braſs Syringe, with Glaſſes for Cupping	1	1	0
Ditto	1	5	0
Hydrometers in Ivory	0	5	6
Speaking Trumpets, from 10*s.* 6*d.* to	1	11	6
Hearing Trumpets, from 7*s.* 6*d.* to	1	1	0

Optical Inſtruments.			
A Four-Foot Reflector, Mahogany Tube	31	10	0
A Three-Foot reflecting Teleſcope, mounted on a Braſs Foot, with Rack-Work	28	0	0
A Two-Foot Reflector	11	11	0
Ditto, with Rack Work from 14*l.* 14*s.* to	21	0	0

H 2 Ditto

	l.	s.	d.
Ditto, 18 Inches	8	8	0
Ditto, 12 Inches	5	5	0
Ditto, 6 Inches	3	3	0
Refracting Teleſcopes of various Lengths and Prices with 4, 5, or 6 Glaſſes.			
A large Parlour Compound Microſcope	3	13	6
Ditto, Braſs	5	5	0
Solar Microſcope in Braſs, of the lateſt Improvements	5	5	0
Wilſon's Microſcope, and Apparatus	2	12	6
Ditto, ſmall	1	7	0
Dr. Liburkun's Opake Microſcope	2	12	6
Ditto	3	13	6
Cloth Microſcopes	0	7	6
Diagonal Machines for viewing Prints	1	11	6
Ditto, on a Mahogany Foot	0	16	0
A large Book Camera Obſcura	4	14	6
Ditto Common	2	2	0
Scioptric Ball and Socket, in Wood	0	7	6
An Artificial Eye, in Braſs	2	2	0
Opera Glaſſes, from 5*s* to	1	11	6
Magic Lanthorn, excluſive of Objects	1	1	0
Mirrors, Convex or Concave, of all Sizes, hung in Frames, from 12*s.* 6*d.* to	16	16	0
Priſms, from 5*s.* to	1	1	0
Reading Glaſſes, from 2*s.* 6*d.* to	2	12	6
An Aquatic Microſcope	2	12	6
A Set of Six *Anamorphoſes*, or deformed Pictures, rectified by a reflecting poliſhed Cylinder	2	2	0

Mathematical Inſtruments.			
Theodolites from 6*l.* 16*s.* 6*d.* to	21	0	0
Plain Table	3	13	6
Gunter's Chain	0	7	6
Hadley's Quadrant, with Diagonal Diviſions	1	18	0
Ditto, with a *Nonius* Ivory Limb	2	15	0
Ditto, 18 Inches, all in Braſs	6	6	0
Ditto, 12 Inches	4	14	6
Davis's Quadrant	0	12	6
Sutton's Quadrant	0	6	6
Caſes of Inſtruments for Drawing, in Wood, Braſs, Ivory, or Silver, from 12*s.* 6*d.* to	26	5	0
Proportional Compaſſes	3	3	0
Ditto, ſmaller	1	11	6
Horizontal Dials, from 10*s.* 6*d.* to	10	10	0

Azimuth

P R I N T S.

SYnopſis of Cœleſtial Science, 3s.
Wonders of the Cometary World diſplayed, 2s. 6d.
The Orbit of the Comet of 1682 and 1759, 1s. 6d.
New Map of the World, 1s. 6d.
Map of 460 Miles round *London*, 6d.
Ditto, 20 Miles round *London*, 6d.
Geographical Fire-Screens, from 3s. 6d. to 5s. 6d.
The Tranſit of *Venus* over the Face of the Sun, as it appeared *June* 5, 1761.

N. B. Whereas the *Pedlars*, &c. in all Parts of *England*, ſell *Viſual Glaſſes* with the Initials of my Name, B. M. upon them, and pretend on that Account that they are of my Make, and were bought of me, I thought it neceſſary to undeceive the Public by aſſuring them, that I never ſold any to thoſe who hawke Goods about the Country, they dealing in a Sort of Glaſs too bad for any but themſelves to recommend, or for any one to buy who knows any Thing of Optical Glaſs, or has more Regard to the Safety of his Eyes, and the Preſervation of his Sight, than to the ſaving of his money.

Reprint of portion of an article appearing in *Sands, Clays & Minerals*, Vol. III, No. 3, April, 1938, published by A. L. Curtis, Westmoor Laboratory, Chatteris, England.

A.S.T.M. Standards Embodied in California Regulations for Public School Constructions

Many members of the Society may be interested to know of another rather extensive use of A.S.T.M. specifications and tests in connection with the field of building construction. Most members on the Pacific Coast are familiar with the California legislation in connection with the construction of public school buildings, but there are many other members probably not so familiar with this.

Several years ago the California Legislature to insure safe building construction for school children invested the Division of Architecture of the State Department of Public Works with the authority to approve or reject plans and specifications and to supervise the construction of all public school buildings, therefore making mandatory the preparation of adequate designs and specifications in the safe construction of public school buildings. The rules and regulations were revised in February, 1937. The act provides that all plans and specifications must be prepared by a certified architect or by a structural engineer.

Of interest to Society members, among other items, is the appendix covering Structural Design and Materials with Details of Construction. In the section on tests under standards, it is stated that "Sampling, preparation of samples and tests shall be in accordance with the standards as latest adopted by the American Society for Testing Materials, unless otherwise provided in the approved specifications or in these regulations."

Various chapters of the regulations cover design factors and such topics as masonry, gypsum, wood, cement, steel and similar related essentials. In these chapters there are incorporated quite a number of A.S.T.M. specifications and tests as part of the regulations. All told, there are references to some 25 A.S.T.M. standards. These cover such materials and subjects as the following:

Lime	Concrete Reinforcing Steel
Gypsum	Tests of Concrete and Aggregates
Brick	Structural Steel
Cement	Steel Castings
Masonry Units	Steel Pipe
Concrete Aggregates	Zinc-Coated Sheets

This use of A.S.T.M. specifications and tests is another of the many examples where those responsible for codes and regulations have found the Society's standards of service in providing for the quality of structural materials.

Western Chemical Congress in 1939

In August, 1939, during the Golden Gate International Exposition, the Western Chemical Congress will convene. The organization of this is in the charge of a committee of leading technologists on the Pacific Coast. A number of societies, associations and industrial corporations are interested in the congress and are cooperating with the committee in planning for it. The major theme is stated as "The Place of Chemistry in Modern Life" and it has the object to foster advancement of chemical knowledge and development of chemical process industries in the West. Facilities are to be arranged for separate meetings of the various societies and associations participating.

Quite a list of general subjects are to be covered, including many which will be of interest to A.S.T.M. members. Such topics as metallurgical chemistry, ceramic and glass chemistry, cement chemistry and technology, petroleum, paint and varnish chemistry, etc., are some of the individual subjects which will be represented in the program. It is planned that the papers will be devoted especially to the practical aspects of industrial questions.

Several A.S.T.M. members are taking an active part in the plans for the congress including the following who are members of the organization committee: Dozier Finley, Director of Technical Research, The Paraffine Cos., E. E. Smith, President and General Manager, Smith, Emery and Co., and J. B. Terry, Chief Chemist, Standard Oil Co. of California.

More (or Less) About Gray Hair

There was reprinted in the October Bulletin, page 35, a scientific explanation of what causes gray hair as taken from an Inter-Society Color Council News Letter. One of our members calls attention to two other theories which may be of interest. The first one is as follows:

> "In early life the roots of the hair do not penetrate deeply into the skull and during this period the hair is brown or yellow or pink as the case may be. However as time goes on the roots penetrate more and more deeply in search of sustenance until at about the time of the middle age spread they emerge on the inner side of the skull. This is the crucial time; if, under these conditions the roots encounter gray matter the hair turns gray, but if they encounter a vacuum the hair falls out."

A later theory on this important phenomenon was advanced by a bald-headed friend of the member (it is assumed that the first theory was from a gray-haired individual) which depending on the viewpoint may appear to be more valid and better fit the facts relating at least to part of the phenomenon. This presumes "that in certain highly intelligent persons of great intellectual vigor the brains whirl around at such a rate just below the skull that they cut off the roots of the hairs when they penetrate so far and then the hair falls out."

Because of his difficult position between gray-haired and bald-headed friends the member submitting these theories has not offered much constructive discussion other than a statement that some research is evidently needed and the fact that he has knowledge of several people whose heads might well be cut open for scientific observation.

Editor's Note.—While the editor is not sure that he has the honor of being included in this last-named group of people, he has his suspicions. Other members of the Society may have some ideas or theories causing gray hair or absence of these small filaments and may wish to submit these theories for consideration if a research program is instituted. It is not supposed that this will involve such factors as leiotrichy, cymorichy (not "some are itchy") or ulotrichy.

Columbus Gallery of Fine Arts.

(See page one)

Calendar of Society Meetings

(*Arranged in Chronological Order*)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS—Annual Meeting, December 5-9, New York City.

AMERICAN SOCIETY FOR THE ADVANCEMENT OF SCIENCE—December 27-31, Richmond, Va.

SOCIETY OF RHEOLOGY—December 28-29, Mellon Institute, Pittsburgh, Pa.

SOCIETY OF AUTOMOTIVE ENGINEERS—Annual Meeting and Engineering Display, January 9-13, 1939, Detroit, Mich.

AMERICAN SOCIETY OF CIVIL ENGINEERS—Annual Meeting, January 18-20, New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Winter Convention, January 23-27, New York City.

AMERICAN CONCRETE INSTITUTE—35th Annual Convention, March 1-3, New York City.

American Society for Testing Materials—Committee Week and Regional Meeting, March 6-10, Columbus, Ohio.

AMERICAN CERAMIC SOCIETY—Hotel Stevens, April 16-21, Chicago, Ill.

AMERICAN WATER WORKS ASSOCIATION—Annual Convention, June 11-15, Atlantic City, N. J.

Folders and Literature Received

SCHUTTE AND KOERTING CO., Twelfth and Thompson Sts., Philadelphia, Pa. Steam Jet Exhausters and Compressors, Bulletin No. 4-E. A 21-page publication explaining the construction and operation of the standard exhausters and compressors and of other types built for special operating conditions.

Water Jet Exhausters and Compressors, Bulletin No. 4-P. An 18-page publication describing the use, applications, etc., of water jet exhausters and compressors.

GEORGE SCHERR CO., 128 Lafayette St., New York City. A four-page folder describing Mauser Precision Tools such as caliper and height gage, bevel protractor, depth gage, knife-edge straight edges, etc. Supplementary folder lists benefits from their use.

LEEDS & NORTHRUP CO., 4901 Stenton Ave., Philadelphia, Pa. Thermionic Amplifier for Voltage Measurements in High-Resistance Circuits. Catalog E-OOA. An 8-page catalog describing the thermionic amplifier which adapts any potentiometer of suitable range for glass electrode measurements and other measurements of potential in high resistance circuits.

Notes on Fault Location in Cables. Notebook E-53-441. A 52-page pocket-size book giving facts helpful to the tester when locating any of a variety of faults.

Wenner Thermocouple Potentiometer for Highly Precise Measurements of Voltage. An eleven-page folder describing this recently announced L & N potentiometer for the measurement of thermocouple and other voltages.

FEDERAL PNEUMATIC SYSTEMS, INC., 127 N. Dearborn St., Chicago, Ill. Air Classifiers. Bulletin No. 5. A five-page folder describing the Federal centrifugal classifier, a precision instrument, under instant control for mesh, during operation, with single valve convenient to the floor.

Laboratory Systems. Bulletin No. 25. A six-page folder describing the Federal Laboratory Air Classifying Unit A. In ceramic, metallurgical, and non-metallic research, this device fractionates pulverized material far beyond the power of test sieves.

THE WALLACE G. IMHOFF CO., Vineland, N. J. Vol. 1, No. 1, an 8-page folder describing "The Treatment of By-Products Formed in the Hot-Dip Galvanizing Process." Vol. 1, No. 2, an 8-page folder giving a Bibliography of Technical Articles.

RIEHLE TESTING MACHINE DIVISION, American Machine and Metals, Inc., East Moline, Ill. New pamphlet available covering the Riehle precision pendulum load indicator for testing machines of the hydraulic or lever type. Another describes the low-priced Riehle model "505" universal hydraulic testing machine (capacities of 10,000 to 60,000 lb.) for tension, transverse, compression; also Brinell hardness attachments.

New pamphlet covering the Riehle precision hydraulic universal testing machine—Model P-2, for capacities of 20,000 to 300,000 lb. Describes the hydraulic measuring and loading system; Riehle precision pendulum load indicator with four load ranges; handwheel control for stepless regulation of testing speeds and return.

GENERAL RADIO CO., Cambridge, Mass. Catalog K, a 215-page book, describes industrial devices, resistors, capacitors, inductors, bridges and accessories, oscillators, amplifiers, meters, etc., manufactured by this company.

E. LEITZ, INC., 730 Fifth Ave., New York City. Pamphlet 1264, describing the wide field binocular microscope model RBM for the oil scout and geologist. Four pages.

Foreign Standards Recently Issued

Standards issued by a number of engineering and technical organizations in foreign countries are received by the Society as they are adopted. Since members of the Society may be interested in knowing that such standards are available they will be listed in the ASTM BULLETIN.

Recently the following standards have been issued:

BRITISH STANDARD SPECIFICATIONS FOR:

- Overhead Line-Wire Material (Non-Ferrous) for Telegraph and Telephone Purposes (Nos. 174 to 181—1938).
- Galvanized Iron and Steel Wire for Telegraph and Telephone Purposes (Nos. 182 to 184—1938).
- Plain Linoleum and Cork Carpet (No. 810—1938).
- Mild Steel Drums for Lubricating Oils (No. 814—1938).
- Under-Floor Non-Metallic Ducts for Electrical Services with Fittings (No. 815—1938).

BRITISH STANDARD METHODS FOR:

- Sampling and Testing of Mineral Aggregates, Sands and Fillers (No. 812—1938).

BRITISH STANDARD:

- Terms and Definitions Applicable to Hardwoods and Softwoods (No. 565—1938).
- Chemical Symbols and Abbreviations (No. 813—1938).

NEW ZEALAND STANDARDS INSTITUTE SPECIFICATIONS FOR:

- New South Wales Desapped or Dressed Desapped Hardwood Poles (N.Z.S.S. 168).
- Classification and Grading of New Zealand Building Timber (National Grading Rules) (N.Z.S.S. 169).

CANADIAN ENGINEERING STANDARDS ASSOCIATION SPECIFICATIONS FOR:

- Construction and Test of Flexible Steel Conduit (No. 56—1938).

JAPANESE ENGINEERING STANDARDS ASSOCIATION STANDARD ON:

- Lead (NO 225 H 25).
- Hydraulic Lime (4290).
- Tool Steel (4111).
- Steel Wire (4198).
- Paper (244).
- Raw Soybean Oil (311).
- Cotton Yarn for Knitted Goods and Stockings (1939-1943).
- Rolled Steel (4197).
- Acetic Acid (4191).
- Silk Tissues (1882).
- Rayon Tissues (1881).
- Fancy Goods (1859-1867).
- Cotton Yarn (1956).
- Flax Tissue for Bags (1875)
- Flax Sacks for Products (1874).
- Rules for Sorting Woolen and Cotton Yarn (1853).
- Methods of Determining the Gas Permeability of Refractories (4312).

NETHERLANDS STANDARDS ASSOCIATION STANDARDS FOR:

- Refractory Brick, Execution of Tests for Seger-Cone Number and Transformation Under Pressure (N 412).
- Refractory Brick, Execution of Tests for Real and Apparent Specific Gravity and Real Porosity (N 413).
- Refractory Brick, Execution of Tests for Apparent Porosity and Alteration of Length (N 414).
- Refractory Brick, Execution of Chemical Tests (N 415 and N 416).
- Refractory Brick, Denominations and Dimensions (N 465).
- Sand-Lime Building Brick, Definitions and Tests for (N 522 and 523).
- Mineral Oils, Viscosity Determination, Apparatus, and Execution of Tests (N 607, N 608, and N 609).
- Mineral Oils, Apparatus for Distillation Tests, and Thermometers for Distillation Tests (N 610 and N 611).
- Mineral Oils, Distillation Test on Light Fractions (benzine, kerosine, etc.), Description of Apparatus and Execution of Test (N 612 and N 613).
- Mineral Oils, Distillation Test on Gas Oil, Diesel Oil and Similar Products, Execution of Tests and Description of Apparatus (N 614 and N 615).
- Raw Tung Oil for the Preparation of Paints and Varnishes (N 599).
- Armoured Telephone Cable with Air and Paper Insulation for Local Telephone. Twin Cable; Conductors 0.8 mm. diameter, General Rules (N 552).
- Pipe Conduits and Accessories, Seamless Steel Pipes, Prescriptions for Testing and Execution of Testing (N 417, N 418, and N 419).

Creep Data Chart Available

A FORM for recording data and results of long-time (creep) high-temperature tension tests in accordance with A.S.T.M. Tentative Method E 22 – 38 T has been prepared and members and others who are interested can obtain pads containing 25 sheets of the form at $1 per pad. These forms are printed on thin, durable paper, size 11 by 20 in. Provision is made for recording description of material, the chemistry, grain size, initial physical properties, manufacturing data, room temperature properties of specimens after creep tests and creep characteristics. Space is also available for photomicrographs showing the initial microstructures and the structures of completed creep specimens.

The forms have been designed for use in typewriters with pica size type and the paper stock is such that it can be blueprinted.

"Properties of Glass" by G. W. Morey

RECENTLY published by the Reinhold Publishing Corp., as No. 77 in the American Chemical Society's series of scientific and technologic monographs, is the extensive book on "The Properties of Glass" by Dr. George W. Morey, Member of the Staff of the Geophysical Laboratory, Carnegie Institution of Washington, Washington, D. C. In the preface Doctor Morey points out that our knowledge of the properties of glass today is far more accurate and complete than when his book was started over ten years ago, a result due not only to the interest of academic workers, but also to an awakened realization by the glass industry that the soundest foundation for a strong industry is the understanding of its fundamental scientific principles.

It is not possible adequately to review this important publication within the space available. A list of the chapter headings will indicate the general classification of the subjects discussed, each of which is covered in complete detail.

The History and Definition of Glass	Coefficient of Expansion
Devitrification	Elastic Properties
Composition	Strength
Chemical Durability	Thermal Endurance
Viscosity	Hardness
Annealing	Optical Properties
Surface Tension	Electrical Conductivity
Heat Capacity	Dielectric Constant, Dielectric Loss, and Dielectric Strength
Heat Conductivity	Magnetic Properties
Density	Constitution

A great deal of data and information are given in the form of tables and diagrams. There are upwards of 800 literature references given, of which some 500 are to works published since 1920, and 400 to works published since 1924. Doctor Morey uses this figure to indicate the intensive study which has been made of glass properties in the last ten years or so. A detailed index of some 20 pages is a valuable part of the publication. Copies of this book (561 pages) can be obtained from the Book Department, Reinhold Publishing Corp., 330 W. Forty-second St., New York City, at $12.50 per copy in blue cloth binding.

Doctor Morey, the author, is one of the country's outstanding authorities in the field of glass. He is chairman of A.S.T.M. Committee C-14 on Glass and Glass Products.

1938 Book of Tentative Standards

THE 1938 edition of the Book of A.S.T.M. Tentative Standards is nearing completion and in the very near future copies of the publication will be sent to all members and others who have ordered it. This extensive volume gives in latest approved form *all* of the tentative specifications, test methods and definitions except those involving methods of chemical analysis of metals which are issued in a special compilation. In the 1938 edition, there are some 60 tentative standards relating to ferrous metals, 55 cover non-ferrous metals and alloys, 47 in the cement, concrete, clay products and related cementitious fields, 187 pertain to paint, petroleum and other materials classed in the "D" group, while 16 pertain to general testing methods, etc. A total of 365 tentative standards are included.

This publication is the only one which gives all of the Society's tentative standards. In addition to the large number of new ones published for the first time this year, all the tentative standards continued from previous years are included.

The 1938 volume is the most extensive one yet issued by the Society and contains upwards of 1800 pages. Copies of the publication can be obtained by members at the special price of $4.50, paper binding; $5.50, cloth. The list prices are $7 and $8 respectively.

Dudley Medal Committee Appointed

THE Committee on Award of the Charles B. Dudley Medal has been appointed by the Executive Committee and consists of the following members:

M. F. SAYRE, *Chairman,* Professor of Applied Mechanics, Union College
C. H. DAVIS, Assistant Technical Manager, American Brass Co.
C. H. SCHOLER, Professor of Applied Mechanics, Road Materials Laboratory, Kansas State College of Agriculture

This committee will review the eligible technical papers presented at the 1938 annual meeting in Atlantic City and select the one of outstanding merit which constitutes an original contribution on research in engineering materials. The award will be made at the Forty-Second Annual Meeting in Atlantic City, June 26-30, 1939. This Medal was established in 1925 by voluntary subscriptions from members of the Society as a means of stimulating research, recognizing meritorious contributions to the *Proceedings,* and in commemoration of the first President of the Society whose leadership has profoundly influenced A.S.T.M. development.

NECROLOGY

We announce with regret the death of three members and representatives:

A. W. ARMSTRONG, President, The Wood Preserving Corp., Pittsburgh, Pa. Mr. Armstrong represented his company on Committee C-5 on Fire Tests of Materials and Construction and Subcommittees II and V.

GEORGE L. BAXTER, Chief Chemist, Southern Pacific Railroad Co., Sacramento General Shops, Sacramento, Calif. Member since 1930. Mr. Baxter was a member of Committee D-1 on Paint, Varnish, Lacquer, and Related Products with assignment to Subcommittees VIII, XV, and XXVI.

JOHN R. MCKEAN, Assistant Manager, Kennecott Wire and Cable Co., Phillipsdale, R. I. Mr. McKean represented his company on Committee D-13 on Textile Materials.

NEW MEMBERS TO NOVEMBER 18, 1938

The following 27 members were elected from October 7 to November 18, making the total membership 4182:

Company Members (4)

Atwood Machine Co., The, W. McL. Fraser, Director of Research, Stonington, Conn.

De Bataafsche Petroleum Maatschappij, N. V., 30 Carel van Bylandtlaan, The Hague, The Netherlands.

Freeport Sulphur Co., D. B. Mason, Consulting Chemist, 122 E. Forty-second St., New York City.

Warwick Chemical Co., H. W. Rose, Sales Manager, 100 Pulaski St., West Warwick, R. I.

Individual and Other Members (23)

Bayard, R. A., Chief Engineer, Chromium Mining and Smelting Corp., Box 968, Sault Ste. Marie, Ont., Canada.

Betz, C. E., Technical Director, Magnaflux Corp., 605 W. Washington St., Chicago, Ill.

Chattanooga, Electric Power Board of, S. R. Finley, Chief Engineer, 14 Municipal Building, Chattanooga, Tenn.

Colby, G. E., Engineer, International Braid Co., 47 Charles St., Providence, R. I.

Dudley, A. W., Testing Engineer, E. L. Conwell and Co., Philadelphia, Pa. For mail: 910 E. Rittenhouse St., Philadelphia, Pa.

Fox, L. R., Vice-President and General Manager, Onondaga Silk Co., Inc., Easton, Pa. For mail: 641 N. Thirteenth St., Easton, Pa.

Hamilton, L. W., Associate Engineer, In Charge of Soil Laboratory, U. S. Bureau of Reclamation, Denver, Colo.

Johnston, J. C., President, Atlas Asbestos Co., North Wales, Pa.

Kessler, M. J., Chief, Inspections and Tests, S. J. Kessler, Consulting Engineer, 118 E. Twenty-eighth St., New York City.

Mauersberger, H. R., Technical Editor, Rayon Publishing Corp., 303 Fifth Ave., New York City.

Moore, E. B., Superintendent, The Bridgeport Fabrics, Inc., Bridgeport, Conn.

Mulcahy, B. P., Research Engineer, Citizens Gas and Coke Utility, 47 S. Pennsylvania St., Indianapolis, Ind.

New York City, Manhattan Department of Borough Works, Division of Design, J. C. Collyer, 2134 Municipal Building, New York City.

New York City, Department of Public Works, W. S. Elliott, Engineer of Tests, Municipal Building, New York City.

Noyes, G. E., Chief Chemist, Southern Pacific Co., Sacramento General Shops, Sacramento, Calif.

Owen, M. B., Vice-President, Nichols Engineering and Research Corp., 60 Wall Tower, New York City.

Peebles, J. C., Research Engineer, Research Foundation, Armour Institute of Technology, 3300 Federal St., Chicago, Ill.

Sao Paulo, City of, Repartiçao de Aguas e Escotos, Director, Rua Riachuelo 25, São Paulo, Brazil.

South African Railways and Harbours Technical Library, Librarian, Railway Headquarters, Johannesburg, South Africa.

University of Tennessee, Textile and Clothing Dept., Ida Anders, Professor of Textiles and Clothing, Knoxville, Tenn.

Vormelker, P. S., Chief Chemist, Aetna Rubber Co., 815 E. Seventy-ninth St., Cleveland, Ohio.

Waples, H. H., Room 500, Procurement Division, Washington, D. C.

Watson, William, Androscoggin Mills, Augusta, Me. For mail: Box 588, Lewiston, Me.

PERSONALS

* * * News items concerning the activities of our members will be welcomed for inclusion in this column.

J. R. Baylis, Physical Chemist, City of Chicago, was awarded the Dexter Brackett Memorial Medal at the 1938 annual meeting of the New England Water Works Association, in recognition of his outstanding work in water purification.

Paul Logue, formerly in Charge of Operations, Swann and Co., Birmingham, Ala., is now in the Sales Introductory Dept., Monsanto Chemical Co., St. Louis, Mo.

W. K. Hatt, Research Professor, Purdue University, will retire, January 1, 1939, from active duty at Purdue in Lafayette, Ind., after forty-five years of service, with the title of Emeritus Professor of Civil Engineering. Following a short period of travel to Australia, he will maintain residence at Purdue University.

L. H. Fry, Railway Engineer, Edgewater Steel Co., will be presented with the Worcester Reed Warner Medal at the annual meeting of the American Society of Mechanical Engineers on Honors Night, December 6, for "written contributions relating to improved locomotive design and utilization of better materials in railway equipment."

Joseph Winlock, Chief Metallurgist, Edward G. Budd Manufacturing Co., Philadelphia, is co-recipient of the Henry Marion Howe Gold Medal of the American Society for Metals.

F. E. Foss, Professor of Civil Engineering for the past 29 years, Cooper Union, New York City, will be retired at his own request at the end of this academic year. R. C. Brumfield, Assistant Professor of Civil Engineering, Materials Testing Laboratory, Cooper Union, New York City, has been appointed acting head of his department for the coming school year.

At the recent annual meeting of the American Welding Society Office of Chief of Ordnance, Washington, D. C., was made senior held in Detroit, Colonel G. F. Jenks, Chief of Technical Staff, vice-president; C. A. Adams, Professor of Engineering, Emeritus, Harvard University, and Consulting Engineer, Edward G. Budd Manufacturing Co., and F. T. Llewellyn, Research Engineer, United States Steel Corp., were among those chosen as directors.

ALLEN ROGERS
1876-1938

Dr. Allen Rogers, Emeritus Head of the Department of Chemical Engineering at Pratt Institute, died at his home in Hampden Highlands, Maine, on November 4 after an extended illness. He was graduated from the University of Maine in 1897, and received his Ph.D. from the University of Pennsylvania in 1902. He was an instructor in chemistry at the University of Maine from 1897 to 1900, and at the University of Pennsylvania until 1904. During 1904-1905, Doctor Rogers was research chemist for the Oakes Manufacturing Co. In 1905 he joined the faculty of Pratt Institute, and in 1920 was made Head of the Department of Chemical Engineering and Supervisor of that course. These positions he filled until illness forced his retirement.

His numerous publications in the field of industrial chemistry and in leather technology are standard reference works in those subjects, especially his "Manual of Industrial Chemistry."

Doctor Rogers had been affiliated with A.S.T.M. since 1910. In this same year he became a member of Committee D-1 on Paint, Varnish, Lacquer, and Related Products. He has been very active in the work of various D-1 Subcommittees and from 1920 to 1938 served as Chairman of Committee D-1. He was elected to the A.S.T.M. Executive Committee in June of this year but because of continuing poor health, resigned during the summer.

In addition to his A.S.T.M. membership he was affiliated with the Chemists' Club of New York and held offices in the American Chemical Society, American Institute of Chemical Engineers, Society of Chemical Industry, American Institute of Chemists, Technical Association for the Fur Industry, American Leather Chemists Association, and the Association of Consulting Chemists and Chemical Engineers.

In his death many members of the Society lose a close friend and associate while the Society loses an earnest supporter over a period of many years.

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DECEMBER, 1938

ASTM BULLETIN

American Society for Testing Materials

260 S. Broad Street Philadelphia, Penna.

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PROFESSIONAL CARDS

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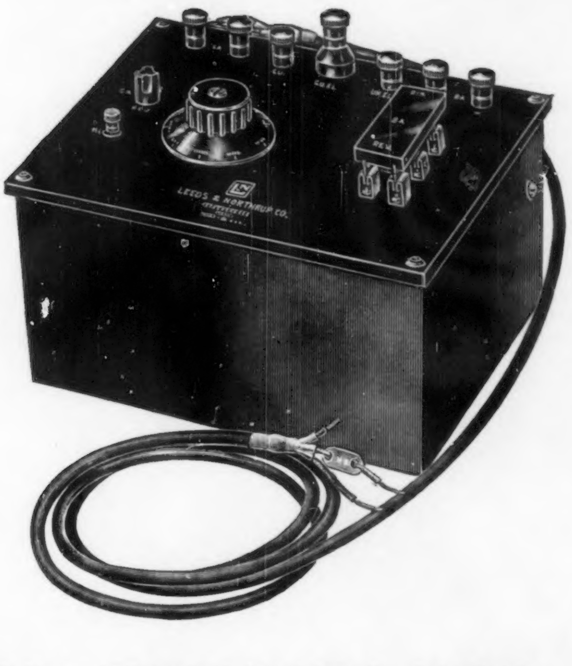

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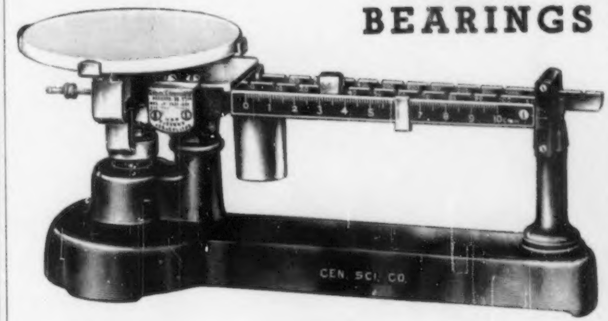

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